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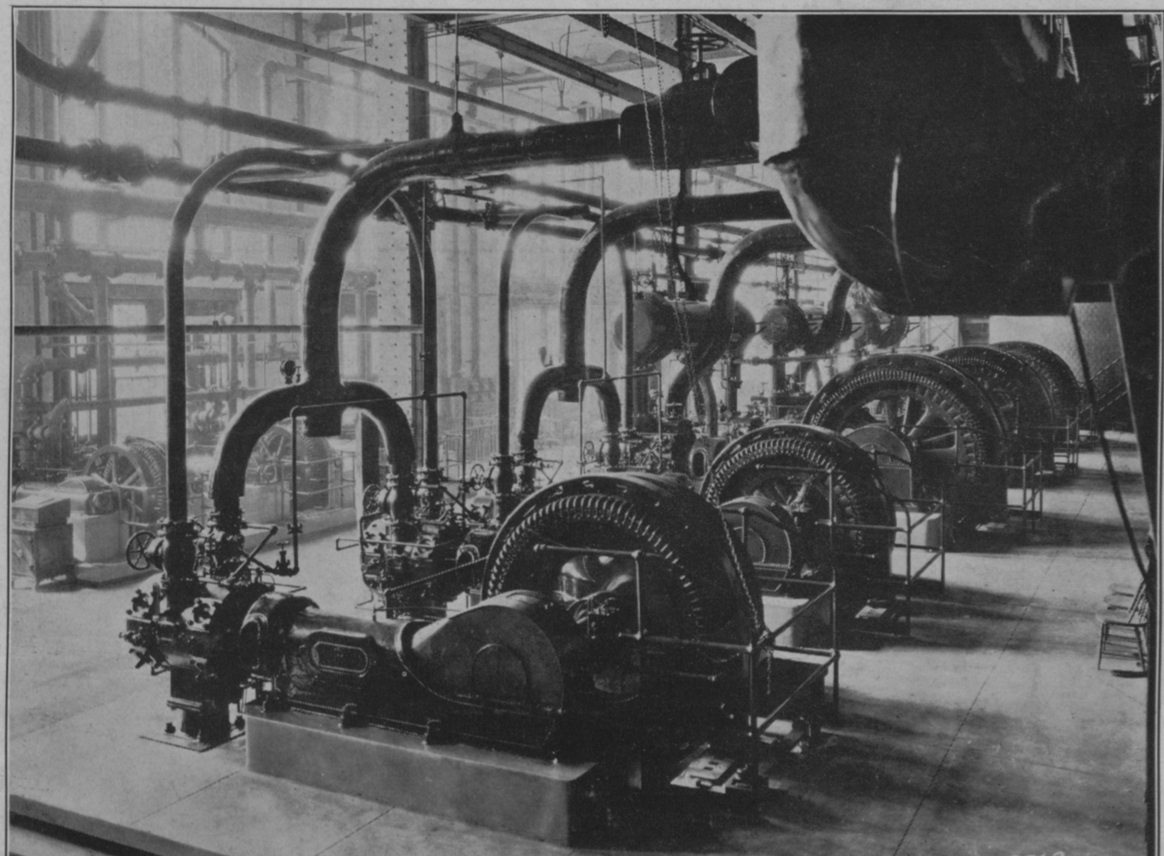

Two 225-Ton Duplex Compressor Units, in the Foreground, of a 1000-ton Ice Plant.

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Detroit, Michigan
ALBERT F. KAHN, Architect

Drawn by Hugh Ferriss

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Vol. XXXIV TERRE HAUTE, INDIANA, JANUARY, 1925 No. 4

THE TECHNIC

MEMBER OF ENGINEERING COLLEGE MAGAZINES ASSOCIATED

PROF. LESLIE F. VAN HAGAN, Chairman..............University of Wisconsin, Madison

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Summary of Contents

In Memoriam

DR. EDWIN SHELDON JOHONNOTT
CLASS OF '93

Friend
Teacher
Scholar

November 9, 1868
January 2, 1925

The Life of Dr. Johonnott

Prof. John B. Peddle, M. E., '88

A LITTLE before one P. M., January 2, 1925, Dr. Edwin Sheldon Johonnott, Professor of Physics at Rose, was struck and instantly killed by an interurban car as he was driving into the grounds of the Institute.

His wide circle of friends and acquaintances were stunned by the tragedy, which overwhelmed them by its unexpectedness. Expressions of heartfelt sorrow and the sympathy for his bereaved family have poured in from all sides, and there is a general feeling that the calamity is one from which the Institute will not quickly recover.

Dr. Johonnott was born at Richmond, Ill., November 9, 1868. His connection with Rose began in 1887 when he entered the Freshman class. On account of trouble with his eyes he was forced to drop out in 1889, but he returned in 1891 and finished the course in electrical engineering in 1893. He had a fine scholastic record throughout and at graduation received the Heminway gold medal.

From Rose he went to the United States Patent Office where, for a year, he was Assistant Examiner. During the year 1894-5 he was Professor of Physics and Mathematics at Drury College.

While he was a student at Rose he was advised by Dr. Mendenhall, who was then President, to specialize in pure science. This doubtless led him to take the next step, which was to enter John Hopkins as a graduate student in mathematics and physics. He remained here for a year and then, attracted by the fame of Professor Michelson, he transferred to Chicago University where he received his Ph. D. degree in 1898. While at Chicago he held a fellowship for the years 1897-99 and acted as laboratory assistant for Michelson and Milliken.

In 1899 he returned to Rose as a teacher in the Department of Physics, in which position he remained until his death, a few days ago.

In 1900 Dr. Johonnott married Miss Mabel Stevens. He is survived by his widow and an only son, Sheldon, the latter now a student in the Freshman class at Rose.

While engaged on his post graduate work, Dr. Johonnott's teachers were among the best that the country afforded. At John Hopkins he had Rowland and Ames, and at Chicago he had Michelson. Michelson, especially, took a great fancy to the young man, and it was at his suggestion that Dr. Johonnott undertook the investigation of the thickness of liquid films. The results of these investigations were published in the Philosophical Magazine and have become classic in their accuracy and reliability.

During his early years as a teacher at Rose Dr. Johonnott did considerable research work—in fact his chief interest seemed to lie in that direction—and his works on Rayleigh's alternate current phase meter, on the loss of energy by hysteresis in iron, on arc and spark phenomena in transformers and on other subjects of like nature were published in the scientific periodicals of the day and gave him a deserved reputation as an investigator of unusual ability. His name in "American Men of Science" is marked with a star as an indication of valuable original work.

While his natural bent was for pure, rather than for applied science he did a good deal of work of a practical nature. Much of the apparatus now in the Physics Laboratory at Rose is of his design and construction. He also did more or less consulting work of a commercial character for manufacturers, such as devising a method for the electrical determination of moisture in cereal food products; determining the rate of cooling of iron spheres; determining the interference of high tension electric lines with those of lower potential; and, with Mr. Frank M. Stone, determined the feasibility of signalling by sound through the air pipes of railway trains.

During the war he was actively interested in radio work and the training of men for that branch of the service in the army. Since then radio has been something of a hobby with him and he has built a number of sets for his own amusement.

His connection with the various societies and organizations in his line of work includes membership in the American Association for the Advancement of Science, the American Physical Society, the Indiana Academy of Science, the American Association of University Professors, the Indiana Physics Teacher's Club and, as long as it was active, the old Terre Haute Science Club. The Luther Dana Waterman Institute for Research made him one of three Affiliated Research Professors to promote research in Indiana.

He has been a valued member of the faculty of the Rose Polytechnic Institute for twenty-five years and made himself felt as a vital factor in that body. He never shirked any burden that was laid upon him but was always willing to take his share of the administrative duties, which he discharged efficiently and punctually. He had a high ideal of scholarship which he constantly maintained. He believed that a solid foundation of theory was the best preparation for practical work and was fond of talking about the value of what he called the "fundamentals."

His work as a teacher was as thorough and painstaking as everything else that he did. His classes were held up to the mark, and while this is not always a sure road to popularity among the students, it is doubtful if he suffered a material loss on that account. It is certain that he had his students' respect, and, from expressions that they have used since his death, it is evident that he had a warm place in their hearts.

Dr. Johonnott was an active member of the Alumni Association of Rose. He attended all of its meetings and was not backward about expressing his views on any subject that came up for debate. He was honored with the Vice-Presidency of the Association four times and was chosen to represent it as Commencement Speaker in 1899.

Athletics interested him and he did much valuable service on the Faculty Athletic Committee of which he was a member for many years. His vacations were spent on a farm in northern Illinois where he did a great deal of hard work, partly because he liked the exercise and partly to keep himself in good physical condition. Hunting and fishing were favorite forms of amusement whenever he had the time to indulge in them. Essentially he was an out-door man.

Music was another form of recreation of which he was very fond, and he found the time to do a good deal of general reading.

Of Dr. Johonnott's character and personality it is hardly necessary to say much to those who will read this article, yet it must not be allowed to close without some reference to them.

To the writer his outstanding characteristic was a rugged honesty of purpose. He had strong convictions as to what was right and wrong, and while they did not always coincide with those of his associates there was no doubt as to his sincerity, nor was there any doubt as to where he stood on a disputed point. He never knew when he was "licked," and if he had the worst of an argument one day, he was ready to begin it all over again the next.

He had one quality which is rather rare in a man of his temperament, that of being able to acknowledge a mistake when once he was convinced that he had made one, and this he did without attempting to palliate the error or to evade the consequences.

Whenever he gave his friendship it was done wholeheartedly. For a friend he was ready to make any sacrifice of time and effort if he thought it would give pleasure.

Apparently he had a fairly just idea of his own attainments, yet such was his modesty and dislike of anything like brag that whenever he spoke of himself he habitually underrated his own performance.

Dr. Johonnott has left an indelible mark of his strong personality on the faculty and students of Rose, and on the community in which he has lived so many years. While he is no longer with us in the flesh the ideals which controlled his active life, and which are after all the essence of the real man, will have an abiding influence among us long after that which is mortal has been laid at rest.

What is Wrong With Rose Athletics?

This is a question that has caused much discussion among Men of Rose and the Rose Tech Club, of Louisville, presents here a discussion of the subject which has been printed verbatum

There may be several reasons why Rose Athletics are not on the par with our neighboring colleges as it used to be. We will dwell upon only the most important reason why athletics are not what they should be and that is the fraternity. In my mind this is the most serious problem that confronts Rose athletics at this time and has for the last several years.

Reports from Faculty members, students and Alumni have all been more or less coherent inasmuch as fraternities playing harmful parts on our Athletic teams.

It will be necessary for a definite understanding between fraternities in respect to athletics before Rose teams can ever hope to be very successful.

An illustration of the existing condition may serve to make this point clear. During a recent football game that the writer witnessed the Captain repeatedly called plays through left tackle. Left tackle invariably threw them back but right tackle was the strongest point on our team.

However, right tackle happened to be made up of men of a different fraternity, consequently, lack of team cooperation. Such a condition must stop immediately. The Alumni play their part in sustaining Rose athletics. They pay into the Athletic Finance Committee a considerable sum each year. It may be well for the fraternity alumni to investigate this condition and take it up with their respective chapters in order to effect some betterment.

We understand that a fraternity plays a very important part in moulding the part of a college student. Almost without exception it brings out his finer qualities and the trend of the national fraternities of this day and age is to better the fraternity man.

The fundamental objects in the founding of Rose Polytechnic Institute was not for fraternities and she can get along very well without them. It is necessary at this time to have Athletic teams that are successful and if fraternities in any way show the slightest inclination of using their influence improperly, then vigorous action should be taken against their existence.

The writer in summarizing the sentiments and thoughts of what we think one of the livliest Tech Clubs in the Alumni organizations and as a fraternity man, I would hate very much to see my fraternity chapter ruled out of the Institute.

Let us get together as Alumni with our respective fraternity chapters and try to make Rose athletics what it should be.

W. H. JUNKER.

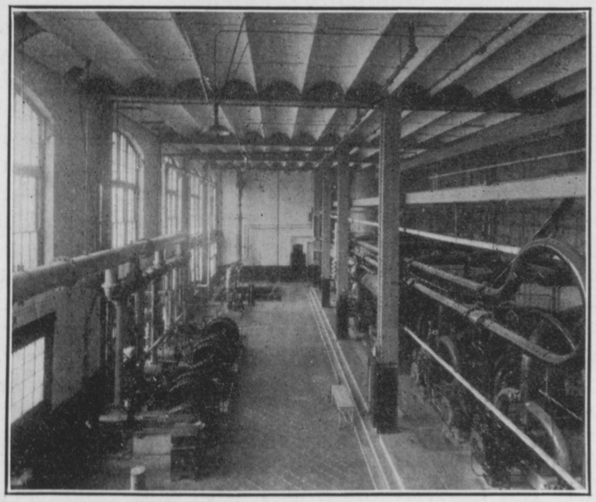
A 1000-Ton Ice Plant

William H. Motz, M. E., '16

IN ORDER to show the mechanical and electrical engineering requirements of one of these large ice making plants, a detailed description of one of the largest plants in the country will be given.

The ice making plant of the Arctic Hygeia Co., of New York was recently converted from a steam-driven, distilled water ice making system, to a motor-driven, high speed compound compressed, raw water ice plant of 1000-ton capacity. This plant was described in one of the recent issues of ICE AND REFRIGERATION. Ophuls and Hill, Inc., were retained as consulting engineers during the designing and installation of the new equipment.

Fig. 1 and front cover show the new engine room complete.



(Fig. 1)
The three Synchronous Motor Driven Aerating Compressors, left-hand foreground of illustration

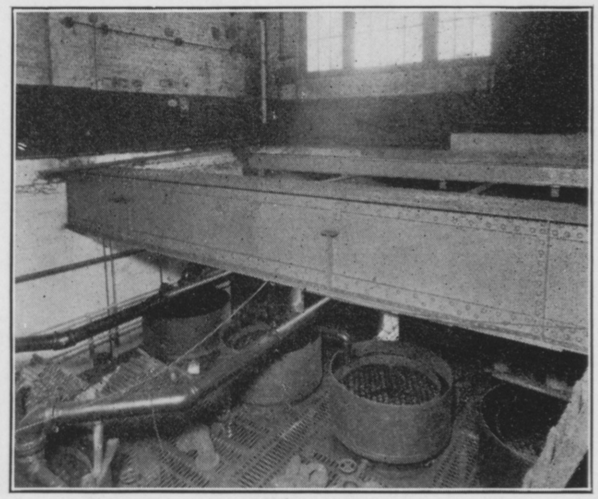
The normal output of this plant is 1,000 tons of ice per day, based on approximately 13.7 standard 300-pound cans per ton. The total yearly electric current consumption of this plant is very great and any material saving that can be made in this current consumption will favorably affect the cost of the ice manufactured. It is therefore of the utmost importance to make use of all the most modern methods and appliances known to the refrigeration industry. Keeping this in mind, it was decided to provide the plant with two independent ammonia suction systems, the one with a suction pressure range from 15 to 30 pounds for the manufacture of ice in the freezing tanks and maintaining proper temperature in the ice storage room, and the second operated at approximately 40 pounds gauge for cooling water used for manufacture turning ice and cooling the liquid ammonia used in the plant after it comes from the ammonia liquid forecoolers.

The existing lines from the freezing system and the suction mains in the engine room were all of such small dimensions that the pressure drop from the coils in the freezing tanks to the machines was excessive. To improve this condition, entirely new suction mains and headers were installed, one suction main coming from each freezing tank floor, all of them in one common 12-in. header in the ice storage room. This 12-in. header terminates at each end in an accumulator, 4 ft. in diameter by 10 ft. high, equipped with liquid coils. The outlet pipes from these accumulators pass into the engine room, being connected respectively to the two ends of a 12-in. suction header to which the refrigerating machines are connected.

The high-pressure suction line from the two fore-cooling tanks on the fourth floor enters a high-pressure suction accumulator, also located in the ice storage room. From here it passes to a high-pressure suction main located behind the two high-pressure refrigerating machines. To obtain maximum flexibility, these two suction mains in the engine room are provided with a valved by-pass so that if desired, the system can be operated on one common back pressure.

A 12-in. low pressure suction header, connected to the two accumulators in the ice stroage room, runs the full length of the engine room. From this header, 10-in. suction lines run to each of the three high-speed, two- stage machines constitute the main large ammonia compressors. These three large, units. The cylinders are 15½ inches by 22½ inches by 24 inches, and are equipped with clearance pockets. They are direct-connected to 750-horsepower synchronous motors, 3-phase, 60-cycle, 440-volt, running at 150 r. p. m., and having a capacity of 400 tons. Each is equipped with a water intercooler between stages. Fig. 3 shows two of the 400-ton compound compressor units in course of erection.

The high pressure suction header is connected to the two 225-ton, high speed duplex machines. These compressors are 11 in. by 18 in., and have clearance



(Fig. 1)
Looking down on Ammonia Condenser

pockets. Both machines operate on a suction pressure of forty pounds gauge and are direct-connected to 350-hoursepower, synchronous motors, 3-phase, 60-cycle, 440-volt, running 200 r. p. m. Front cover shows these two 225-ton duplex compressors in the foreground.

The ammonia compressors are standard ringplate-valve type, provided with clearance pockets to adjust the capacity of the machines to the load requirements.

The discharge from the five refrigerating machines consists of two 8-in. lines. In each line, these is provided a horizontal ammonia vapor cooler, containing 700 square feet of cooling surface, which is really a shell type ammonia condenser. These vapor coolers also serve as oil separators and have proved very effective. There are three vapor passes in the ammonia side of each cooler and eight in the water side. They are 34-in. diameter by 13 ft., 8½ in. long, each containing 100 2-in. tubes. A 7-in. by 8-in. compressor, belt-driven by means of a 250-horsepower motor, is provided for pump-out purposes.

Twelve vertical shell-and-tube ammonia condensers are installed. Each is 47-in. in diameter by 18 ft. high, containing 168 No. 8 charcoal iron tubes, 2½ in. diameter, or 2,000 square feet of condensing surface. They are connected in four batteries of three condensers each, in such a manner that any condenser can be cut out or in at will. The condensers are set on a concrete foundation with a concrete pit under it which is connected to the sewer. As the condensers are open at the top and bottom they can be cleaned while they are in operation. Fig. 2 shows a top view of the condensers.

The two discharge lines are connected by a loop in the engine room, and they are also looped completely around the condensers so that two passages for the discharge vapor are always available. Valves are placed on each side of each machine and at strategic points in the loop around the condensers, thus making the system doubly secure against any shutdown which might be caused by damage to any section of the piping.

From the condensers, the liquid ammonia drops down into three ammonia receivers, 30 in. in diameter by 18 ft., and from there it goes to the various parts of the plant where refrigeration is required.

The supply of cooling water available is pumped 400 ft. from the Harlem River. There are, however, a number of surface wells on the property, the water of which is approximately 58° F., and since the river water in the summer time reaches a temperature as high as 76° and 78° F., a liquid ammonia forecooler of the atmospheric type, 7 stands, 2-in. pipe, 18 pipes high, is installed through which the liquid ammonia passes from the liquid ammonia receivers. Over the outside of this forecooler, well water is circulated, so that the outlet temperature of the liquid coming from this forecooler is within two degrees of the temperature of the well water.

For the reasons before mentioned, it was deemed advisable to cool the liquid ammonia circulated in the plant in two stages. Therefore, the liquid supply from the forecoolers first passes through the cooling coils in the high pressure accumulators and is here cooled from 60° F. to approximately 32° F. From here, the liquid main branches into two separate lines, each one terminating at the cooling coil header of the two low pressure accumulators. These are 4 ft. in diameter by 10 ft. high, each containing four sets of 2-in. extra heavy steel pipe coils, or approximately 1,180 ft. of pipe. By maintaining a proper liquid level in these accumulators, the liquid ammonia is further cooled to approximately 16° to 18° F. before it is conducted to the expansion valves of the brine cooling coils in the freezing tanks.

A liquid branch is taken off from the main liquid line after it leaves the high pressure accumulator and terminates in the liquid headers of the two raw water forecooling tanks. The high pressure accumulator is the same size as the low pressure accumulator.

The liquid ammonia, after it has been evaporated in the cooling coils of the freezing tanks and in the cooling coils of the ice storage room at a suction pressure of 15 to 30 pounds gauge in the low pressure suction system passes through the suction mains mentioned above to the 12-in. suction header in the ice storage rooms. The liquid evaporated in the water forecooling tank coils passes through the high pressure suction line into the high pressure accumulator.

It is easily seen that to obtain maximum economy in th eoperation of as large a refrigerating system as this is, and also to safeguard its operation as much as possible, special provisions must be made to obtain an efficient liquid distributing system, and one that can be safely handled by the operating crew. It is absolutely impossible for an operating crew to so adjust the great number of expansion or liquid regulating valves of the plant that each one will supply exactly the correct quantity of liquid ammonia to the piping system connected to it. Maximum economy in operation requires that at least that quantity of liquid ammonia be supplied to the cooling coils which can be evaporated in them. To obtain this result, without the maximum care in the adjustment of the expansion valve, the system is first provided with accumulators or liquid separators of such capacity that they can hold a large quantity of liquid ammonia. This permits the opening in excess of the required amount of all the expansion valves in the plant. The liquid ammonia which cannot be evaporated in the cooling coils will therefore tend to return to the refrigerating machines with the vapor produced. Since this mixture of vapor and liquid must first pass through the accumulators, all of the entrained liquid will be removed from the vapor and the liquid which is not evaporated by the warm liquid which is passing through the coils in the accumulators will be deposited in the accumulator shells.

As an additional safeguard to the operation of the machines, a motor-driven ammonia pump, capable of handling liquid ammonia has been installed. It is of the horizontal duplex type, 5½ inches by 12 inches, running at 22 r. p. m., capable of handling 500 lbs. of ammonia per minute, and is driven by a 25 hp. motor. This pump has a capacity large enough to easily hajndle 50 per cent of the liquid ammonia evaporated in the plant when operated at the normal output of 1,000 tons per day. If, therefore, the expansion valves are opened 50 per cent, or more, than they should be, the liquid which reaches the accumulators will be pumped out of the accumulators and returned to the high pressure liquid side of the plant, from which it again flows to the expansion valves.

A purifier system is located in the condenser room to which is connected all the ammonia apparatus and equipment. The purifier shells are 2 ft. in diameter by 8 ft. long.

A high pressure alarm is installed in the high

pressure lines in the engine room. This alarm rings a bell whenever the pressure exceeds ordinary operating conditions.

All of the apparatus on the high pressure side, such as the refrigerating machines, vapor coolers, condensers, receivers, etc., are provided with safety valves in accordance with the safety code of the city of New York, and whenever the pressure becomes excessive, the ammonia escapes through these valves into the low pressure side of the plant.

The ammonia system is provided with meters for indicating and registering the flow of ammonia. A 2½-in. ammonia Venturi meter and manometer is provided in the high pressure suction line for indicating the flow of ammonia. A 5-in. Venturi meter, equipped with indicating and recording mechanism is provided for indicating the total flow of ammonia. In addition to these meters, pneumercators are provided, one for condenser pressure, one for the high pressure suction line, and one for the low pressure suction line.

The universal method used today for manufacturing clear raw water ice is to maintain the water during the process of freezing in a constant state of agitation by means of air blown into it in various ways.

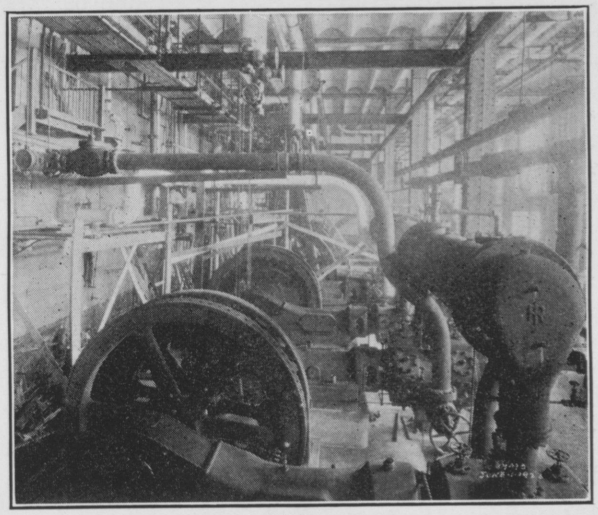
To obtain the proper compressed air supply, three duplex air compressors, 15-in. by 12-in. direct-connected to 150 horsepower synchronous motors running at 225 r. p. m., were installed. These are equipped with clearance pockets and automatic unloading devices.

Each of these compressors has a free air capacity of 1000 cubic feet per minute. The air discharge used is from 25 to 30 pounds gauge. Two of these compressors are more than large enough to operate the plant at a minimum capacity. One of the two machines in operation runs practically all of the time at full load, whereas the second unit unloads from time to time so as to maintain the proper predetermined air pressure. All three compressors are equipped with automatic unloading devices which maintain a reasonably constant discharge pressure. Fig. 1 shows the three synchronous motor-driven aerating compressors in the left-hand foreground.

The air supply of these compressors is taken from the roof of the building through a 20-in. supply pipe which brings the air to the 20-in. header running above the thre machines. The reason for this arrangement is to obtain an air supply as nearly free from dust as possible. The air is supplied to the compressors through 12-in. lines which run from the header to each machine.

The discharge pipes are all collected into an air discharge header running over the machines and a separate 8-in. air pipe passes from either end of this header to the second floor of the building where the cooling and dehumidifying apparatus of the air system is installed.

The dehumidifying apparatus, consists of five separate units. Each unit is equipped with a double-pipe air pre-cooler through which salt water is passed to reduce the temperature of the air to as low a point as possible before it reaches the dehumidifier proper. The double-pipe air coolers are made of 1¼-in. and 2-in. pipe, and are twelve pipes high and 10 ft. long. In each air outlet pipe of these air coolers, a moisture trap is installed so that any condensation contained in the air can be removed. Each one of the double-pipe air cooler stands is also provided with moisture drains. All of these drains are connected to proper traps so that the condensate is automatically discharged into the sewer.



(Fig. 3)
Two 400-ton Machines completed and in action

The five dehumidifiers consist of cylindrical tanks, 40-in. in diameter by 8 ft. high, provided for spiral cooling coils. For cooling and dehumidifying the air, fresh water is used through which the air is forced. This water is maintained at approximately 33° F. by circulating through the cooling coils immersed in the cold brine, which is produced in separate brine coolers installed for this purpose. Fig. 5 shows the rehumidifying system and the brine coolers for same.

The brine cooling system for the dehumidifying apparatus consists of two brine coolers and two brine circulating pumps, each set being large enough for the operation of the plant at full capacity. Calcium chloride brine is used in the system, which is of the closed type, with a small surge tank located at the highest point. The coolers are 26½ inches in diameter by 8 feet long, each containing sixty-six 2-in. charcoal iron tubes, with a total cooling surface of 276 square feet, and are arranged for ten passes of brine; they have a refrigerating capacity of 27 tons per day.

Three of the dehumidifiers are of sufficient capacity for the maximum output of the plant, so that if any one or two of them is out of commission, there is a reserve which can be called upon. The proper dehumidifying of the air is of such importance that it was thought advisable to install five units instead of four, which is the usual practice.

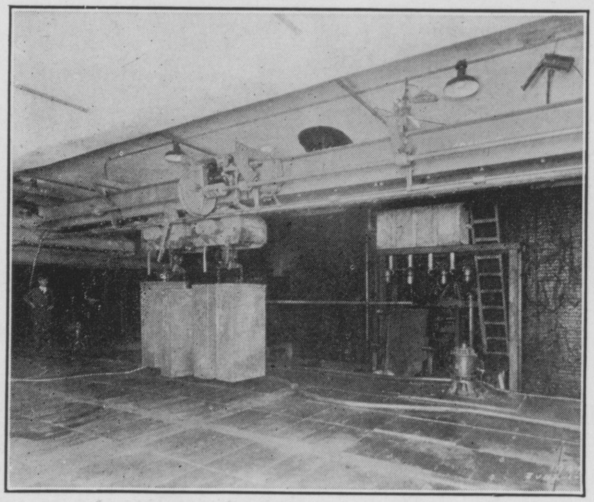
The brine is circulated by two 100 g. p. m. centrifugal pumps, direct-connected to 5-hp. motors.

The dehumidified air at from 25 to 30 pounds pressure leaves the dehumidifiers at the top and enters a large header connecting all five units. To reduce the pressure to the 15 pounds required for the aerating system of the freezing tanks, two pressure-reducing valves are installed, only one of which is used at a time.

The dehumidified, cold, low-pressure air passes

from the dehumidifying system into two main distributing headers, which extend through the wall separating the powerhouse from the freezing system, and terminate in two distinct risers, supplying the necessary air for the three freezing tank floors. This piping system is so arranged that either one of the risers can supply the necessary air for agitation purposes.

The risers terminate in 4-in. air headers on the first and second freezing tank floors and in a 3-in. air header on the third freezing floor. From these air headers, ½-in. air laterals supply each ice can.



(Fig. 4.)
Harvesting end of one of freezing tubes, showing crane and hoists, can filling tanks, vertical agitator, can dumper and ice lowerator

When this plant was originally installed, a 16-in. salt water suction line was run from the building to the Harlem River, a distance of 400 feet. A few years later it was found that it was necessary to have two suction lines so as to eliminate any possibility of shutting down the plant because of the failure of the salt water. The second line installed was eighteen inches in diameter. Both of these lines terminate at the Harlem River in a salt water supply basin, surrounded with galvanized iron netting so as to keep out any large objects floating in the river.

To obtain a much larger quantity of salt water for the new refrigerating system, and also in order not to interfere with the old salt water supply system, an entirely new 24-in. cast iron suction line was installed, terminating at the river end in the same enclosure above referred to. This 24-in. line was laid considerably lower than the other two lines. After making the first excavations for the new line, it was found possible to lay it in such a way that the bottom of the main is at main low tide of the Harlem River at that point.

The new salt water supply line was also provided with a 24-in. twin strainer at the building end. Since the floor level of the pump pit is higher than the bottom of the new main, the strainer was inclined at an angle of forty-five degrees, so that the discharge end enters the pump pit just above the floor level. The outlet from the strainer is connected to a 24-in. cast iron header running along the wall inside of the pump pit. Branches from this header run to three salt-water circulating pumps. Fig. 13 shows two of the three centrifugal salt water supply pumps before the completion of the pumping system.

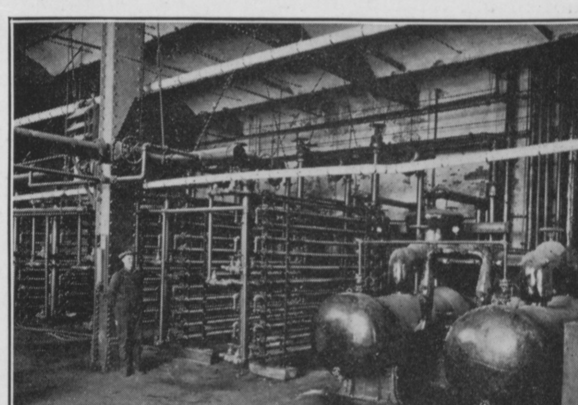
The 12-in. salt water pumps were of the single-stage, double suction, centrifugal type. Two of the pumps have a capacity of 5,000 gallons per minute against a head of 46 ft. and are direct-connected to 100-hp., 440-volt induction motors. The third, a 10-in. centrifugal pump, has a capacity of 2,500 gallons per minute, and is direct-connected to a 50-hp. motor. All three pumps have a maximum hydraulic head of 46 feet.

The discharge from these pumps is connected to a common discharge header, each discharge being provided with a check and a stop valve. From one end of this header, a riser brings the condensing water to the top of the ammonia condensers described before. An 18-in. Venturi tube with a capacity of 1,000 to 10,000 g. p. m. has been installed in this vertical riser with a manometer for indicating at all times, the quantity of water flowing to the condensers.

To overcome any trouble in starting the pumps and to prevent any difficulty from too much air in the suction to these pumps, a piston type vacuum pump, gear-driven from a 10-hp. electric motor, was installed. This is an 18 in. by 18 in. type pump.

So that the operating engineer will know immediately when the condensing water supply to the ammonia condensers is shut off due to any cause whatsoever, an electric alarm horn is installed in the engine room which is actuated by the pressure of the water column in the condensing water system. When the condensing water in the riser to the condensers drops to a pre-determined level, the horn sounds until the supply is restored to normal.

For distributing the water over the condensers, each condenser is provided with two 4-in. condensing water, supply pipes from the condensing water, supply header which is over the ammonia condensers. The condensing water drops into an annular water box on top of the condensers and passes through the bottom of this annular space to the ferrules which are provided in each condenser tube for distributing the water evenly through each tube. The water flowing from the condensers is collected in the pan underneath the condensers and flows from there through two waste lines into the sewer.



(Fig. 5.)
Dehumidifying System and Brine Coolers for same

(Continued on Page 27)

The Computation of Backwater Curves

Roland E. Hutchins

Associate Professor of Civil Engineering, Rose Polytechnic Institute

THE WRITER of this article has had occasion to compute backwater curves, or expected flow lines a great number of times. He had been impressed with the fact that practically all texts on hydraulics attack the problem by the use of backwater functions, usually with the frank statement that they apply to uniform channels only.

Following is a method which is simple and at the same time fits all channels.

In designing a channel to carry a given amount of water, or computing the capacity of a stream, the well-known Kutter-Chezy formula is commonly used. This is composed of three factors: a coefficient, the hydraulic radius, and the slope of the hydraulic gradient. The coefficient is a variable, dependent on three variables combined in a complicated equation. The solution is, however, made easy and rapid by the use of charts and tables.

The solution of this formula for the slope instead of the velocity is all that is required to compute a backwater curve.

The information necessary to compute such a curve is as follows: 1. The discharge expected in cubic feet per second. 2. Enough cross-sections of the strean and their distance apart to represent the average of the channel and to show all abrupt changes. 3. A close examination of the condition of the channel to be able to assign a value of the "n" in the Kutter formula.

For rapid and convenient work some preparation of this data should be made prior to starting the actual computation. It will be found convenient to plot the sections on co-ordinate paper from which the area and wetted perimeter can be measured for three or four elevations above and below the expected flow line. These areas and the hydraulic radii obtained from these sections should then be plotted on the section to which they belong, using area or radius as abscissae and elevation of water surface as ordinates. These curves are of particular value inasmuch as the method is one of "cut and try" and it is necessary to assume an area and then with the assumed data make a computation to see if the assumed data checks the computation made from it.

The method in brief is as follows:—

Determine the elevation of the water surface at the starting point—this will either be found from high-water marks or from a weir, or will be assumed arbitrarily.

This fixes not only the area at the starting point, but also the wetted perimeter and the hydraulic radius.

Next, assume at the first change in section of the stream or at some distance upstream an elevation of the water surface. This fixes the area and radius of that section. The area to use between the first and second sections is the mean of the areas for the two sections, also the mean radius.

Having the mean radius, and the value of "n" assumed for the stream, enter the tables or diagrams for the Kutter formula with this radius and slope assumed for finding the hydraulic properties of the second section. The value of the velocity obtained from these, multiplied by the mean area should give the assumed discharge. If this computed value does not check the assumed discharge, then a new assumption of slope and consequent area and radius will give a new "v" and another computed value of discharge. Usually after a little practice the computer will estimate the correct slope not later than the second try, and many times will estimate it the first time.

Here follows a typical example in which is used a ditch constructed with a base width of 20 feet and one to one side slopes. The grade of the bottom is .001 feet per foot (0.1%). When flowing four feet deep the discharge is 308 cubic feet per second. A submerged dam is constructed at station 0 where the elevation of grade is 560.00. The construction of the dam raises the water surface 1.3 feet (dam is 2.6 feet high). Therefore after building the dam the water is raised from elevation 564.00 to 565.30. It is desired to find the backwater curve resulting from this dam.

The starting elevation is 565.30 feet. The computations are shown in the following table. The arrangement of these is one which the writer has found convenient for this purpose.

A description of how one of the lines was obtained will suffice to illustarte the solution.

From our fundamental data we know that the bottom of the ditch slopes at a rate of 0.1 feet per 100 feet and that its elevation at station 0 is 560.00; therefore, at station 5 the grade will be 560.50. We will assume the water surface slopes .0004 feet per foot. We arrived at this assumption from the following. The water at the dam is at elevation 565.30 and the grade is 560.00. Consequently the depth is 5.30 feet and the area 134 sq. ft. The radius will be 3.8 feet. A value of "n" equal to .030 will apply to a constructed channel like this one. Dividing Q=308 c. f. s. by the area 134 gives a trial velocity of 2.3 feet per second and the corresponding slope must be .00035 feet per foot. We also know that the water surface is not parallel to the grade but will intersect it at some point upstream; hence the areas decrease as we proceed upstream until such time as we reach the portion of the channel where the effect of constructing the dam is no longer felt.

Therefore to accommodate the smaller area we shall have to have a slightly steeper slope to produce a higher velocity. We will assume .0004 feet per foot as the first slope. At station 5 the grade is 560.50 feet and the water surface will be 565.30 plus 500 times .0004 or 565.50 making a depth of 5.00 feet. The area corresponding will be 125 feet and the radius 3.66 feet. The mean area will be 129 sq. ft. and the mean radius 3.73. From this radius and the assumed slope .0004 we find in the table for "n" equal .030 that "v" equals 2.40 feet per second, making "Q" equal 311 c. f. s. This differs from the assumed Q only 1% and the value is close enough. Proceeding in this way, we find that the disturbance caused by the dam plays out at about station 26.

It sometimes happens that the starting elevation cannot be fixed definitely. When such is the case we can assume some elevation, preferably somewhere near what we think should be a proper value, and proceed with the computation. It will be found that the flow line will quickly adjust itself to its proper location. This is reasonable if we stop to think that the formula forming the basis of our computation takes into consideration all of the factors causing flow. A further advantage of this method of computation lies in the fact that two or more simultaneous flow lines can be computed—as for a stream in flood flow when the water is flowing in the channel at a very rapid rate, and that on the flood plain at a much slower rate—that is, two values of "n" apply.

Sta.	Dist. ft.	Area of Section	Mean Area	R	Mean R	Q	V	Slope feet per foot	Slope for Section	Elev. of Water Sur.	Grade of Bottom
0		134		3.8		308				565.30	560.00
5	500	125	129	3.66	3.73	311	2.40	.0004	.20	565.50	560.50
10	500	117	121	3.52	3.59	314	2.60	.0005	.25	565.75	561.00
15	500	111	114	3.40	3.46	316	2.78	.0006	.30	566.05	561.50
20	500	105	108	3.28	3.34	303	2.80	.00065	.32	566.37	562.00
25	500	102	103.5	3.22	3.25	310	3.00	.00075	.375	566.74	562.50

If we assume the same rate of fall in the water surface between stations 25 and 30, the water at station 30 is less than 4 ft. deep—the amount necessary for uniform, steady flow. This indicates that the backwater curve stops between station 25 and station 30. If we assume the same rate of slope to the water as we have between 20 and 25, the depth at 30 would be 3.2 ft. and at 25 4.2 ft. Therefore the 4-ft. depth would occur at 2/10 of 500 ft. from station 25 to station 30, or at station 26.

Smokeless Combustion---a Real Engineering Problem

By Alfred T. Child

Associate Professor of Chemical Engineering, Rose Polytechnic Institute

A discussion of various types of combustibles and their proper method of combustion

DURING that part of the World War in which the United States was actively engaged, and for some years after its close, industrial heating operations were, in many cases, carried on in a very inefficient manner. Supplies of smokeless fuel were impossible to obtain at any price. Smoke ordinances were not enforced. Many cities were obliged to burn high volatile soft coal for the first time. As a result, the smoke nuisance in many sections became very pronounced. Following this period came severe business depression. Plant executives began to pay more attention to fuel economies. Engineers took up the study of combustion problems with renewed interest. Combustion engineering is now a well established branch of the profession, with well-defined functions. One of its major aims is to carry on industrial heating operations without objectionable smoke.

Smokeless combustion does not always mean efficient operation. However, if the combustion engineer has performed his task thoroughly, we can have smokeless, efficient operation, for dense smoke always means wasted heat value. Just what, then, is the work of the combustion engineer. In brief, he is chiefly concerned with the efficient development of industrial heat and in making the largest practical percentage of heat value in any given fuel perform useful work. When he attacks a given problem he begins with fundamental considerations. He must understand the chemistry of combustion, and secondly he must know from experience the conditions under which combustion will function most completely for any specified problem. Let us now consider in some detail the fundamentals of combustion, and finally some of the aids to smokeless combustion which are now available.

The Chemistry of Combustion and Proper Air Mixture

When we speak of the combustible in a fuel, we refer to that part of the dry fuel which will combine with oxygen. Most of the heat from industrial fuels results from the burning or oxidation to carbon dioxide and water. Every fuel, whether solid, liquid, or gaseous, must be raised to a definite temperature before it will ignite and burn. This temperature is called the kindling temperature. We must then always have the combustion space hot enough to ignite the fuel and also any of its products of partial com-

bustion, like carbon monoxide, and the hydro-carbon gases from bituminous coal. This means that we should maintain a good red heat in all parts of the combustion space actively concerned in the combustion of the fuel in order to obtain smokeless operation. Of course it is necessary to supply sufficient air to burn every pound of combustible in the fuel. Actually a considerable excess over the theoretical amount is required. Often this excess amounts to from fifty to a hundred per cent over theoretical requirements. Ordinarily the engineers assumes that it will take about fourteen pounds of air to burn one pound of soft coal completely. It must be remembered that air contains almost eighty per cent of nitrogen which does not assist combustion at all, and, worse still, inevitably carries away a considerable amount of valuable heat in the stack gases. About one half the air needed for combustion can be admitted through the grates. This is the primary air supply. The remainder must be supplied through other openings so arranged that the air will pass over the burning fuel. This is the secondary air supply. If the furnace is using bituminous coal, smokeless operation is very largely dependent on the proper regulation of this secondary air supply. If part or all the secondary air can be preheated by waste heat, nearly all smoke can be eliminated. Many fireman leave the fire door open right after feeding fresh coal in order to furnish sufficient secondary air to combine with the gases that come off so rapidly during the first stages of combustion. These gases include both carbon monoxide and hydro-carbon gases. If the furnace is using soft coal, failure to supply proper air mixture results in loss of heat value in unconsumed fuel and clouds of black smoke from the stack.

Draft

Poor draft is a frequent cause of smoke. While it is true that air currents should pass through the furnace at a moderate rate of speed in order that each volume of air may accomplish as much work as possible, it is absolutely necessary that the flue gases be moved out of the combustion space promptly. Poor draft slows up the removal of the flue gases and consequently the entry of the vital oxygen of the air. Poor draft always causes excessive smoke and lowered boiler efficiency. The proper draft for any given installation may be obtained from standard authorities on the subject.

Ample Combustion Space and Flame Travel

A furnace operating on such a fuel as Indiana bituminous, pulverized coal, or fuel oil, large volumes of gas are evolved during the process of combustion. To handle these fuels properly requires ample combustion space in order that the gases may have room for expansion and mixing with the secondary air to complete combustion. To acocmplish this end the actual firebox is often extended by means of the so-called Dutch oven construction, an extension at the firing end of the boiler. A great many boilers are set too low. Such boilers are hard to fire without smoke and have little flexibility under high loads. Central station boilers are now frequently operated at three hundred per cent over rating without smoke and a very high boiler setting is required for such operation. Boilers having a setting of twenty feet have been installed recently in one large central power station. To prevent radiation and keep the gases hot, the combustion space must be completely lined with high grade fire brick. Modern boilers, particularly of the water tube type increase their efficiency by means of properly located fire brick arches and baffles. Such construction increases the length of time in which the exit gases can give up heat to the boiler tubes and consequently lowers the inevitable heat loss up the stack.

Proper Methods of Feeding

The majority of industrial heating operations using solid fuel require hand firing. Firing a furnace is laborious and often almost incessant work. It also requires a high degree of skill to produce a high average of smokeless and efficient operation. A poor fireman can easily make the best designed furnace smoke when using a high volatile soft coal. Yet a good fireman can and often does accomplish good results with furnaces of rather poor design. Two standard methods are in common use—the coking, and the spreading or alternate method. Under the coking method a rather thick bed of fresh coal is placed on the front grates. When the coal is nearly coked, it is pushed back and fresh coal added in its place. This method produces a bed of incandescent fuel at the back of the furnace over which the gases from the green coal must pass. In the hands of a skillful operator this method produces excellent results. It is generally considered the best method to use in connection with return tubular boilers. The fireman using the spreading method places a small amount of coal over the full length of the grate at alternate doors. Thus he keeps half the fuel bed at the incandescent heat necessary to consume the gases from the green coal just fired. This method also tends to produce smokeless operation and excellent boiler efficiency. For best results, the hand-fired boiler should use only properly sized coal, free from excessive "fines" or coarse lumps. The proper thickness of fuel bed is also a very important item in connection with smoke elimination.

High volatile coals require a bed of four to six inches; coals with less volatile matter require somewhat thicker fuel beds. It is also highly important that conditions for the fireman be made as convenient as possible if he is to carry on his laborious task well and efficiently.

Special Aids to Smokeless Operation —Stokers

The modern, well designed stoker is a most efficient aid in obtaining smokeless operation. The stoker is designed to bring about, by mechanical means the proper furnace design, the ideal combustion cycle when solid fuel is used. This is accomplished by moving the coal by slow degrees toward the hottest part of the combustion space. The time required for the cycle is relatively long in order to give time to coke the coal and burn the gases completely, as well as to extract as much heat as possible from the ash. Three types of stoker are in current use: the overfeed, the underfeed and chain grate.

In the overfeed, the fuel is fed into hoppers at the front end of the furnace and slowly advanced over the grates which are commonly arranged in step formation at a forty-five degree angle. The coal is moved forward by alternate grates which have a rocker motion. This motion also serves to keep the fuel bed and prevent clinkers. The coal is coked on the front grates and the gases pass over the hot fuel bed at the rear.

The underfeed type of stoker is equipped with either horizontal or inclined grates. The coal is

pushed upward by means of screw action or plungers and is finally deposited in retorts where the combustion cycle is finished and the ash removed at the sides. In this type combustion takes place from the top downward, the coal being gradually moved upward toward the hot zone after it is coked.

In the chain grate class the whole fuel bed has a forward motion and is frequently quite long. The ash is dumped into pits from which it may be sluiced away by means of running water. The chain grate and overfeed type seem to be most successful if high volatile, high ash coal is used, and effectively eliminate smoke. The underfeed does best work on low ash coal of the Pennsylvania bituminous type.

Great advances have been made in recent years in stoker design. The tendency is to increase the length of stoker, thus giving more time to consume the volatiles and absorb heat from the ashes. It is claimed that the best types of stoker now leave only four-tenths (0.40) of one per cent of the total heating value of the coal in the ash. while the older, short type often wasted as much as four and one-half per cent in this manner. Formerly stokers were considered available for the large plant only, but now a good mechanical stoker can be had for eight or nine hundred dollars suited to the needs of the small plant. It is stated that a small plant will often save the price of one of these stokers in a single year from the fuel saving alone. A good stoker unquestionably lessens the labor problem and offers the easiest permanent solution of the smoke problem.

Fuel Oil and Pulverized Coal

These two modern fuel systems have achieved marked success in recent years. In many cases they are highly economical and efficient and only brief mention can be made of each. Either method successfully solves the smoke problem if the installation is properly designed and installed. Fuel oil has been used for quite a long time, but pulverized fuel is just coming into general use. Each system requires a large combustion space and special burners and when fuel oil is used, it must be atomized under air or steam pressure into the combustion space. Sufficient secondary air to complete combustion is admitted through special ports in the walls of the furnace and the fine oil spray burns very much like a gas. A pulverized coal installation requires very finely powdered dry coal, fed at a low pressure through burners of special design. The best type of burner is so designed that a ring of finely powdered coal with a core of air at the center is fed at low pressure through the burners and in to the combustion space. As with fuel oil, secondary air is admitted through special ports. These burners are usually placed in the roof of the combustion chamber pointing downward. This arrangement tends to collect the ash at the bottom of the chamber. In each system the mixture of air and fuel is very intimate, and hence the amount of air required approaches very nearly the theoretical. Very high efficiencies are obtained with either system.

In conclusion, it can be stated that smokeless combustion is practical and can be made to pay. That is the province of the combustion engineer. One large malleable plant in Chicago recently installed pulverized coal in its boiler plant in order to abate a smoke nuisance. The installation has been so satisfactory from every point of view that the annealling furnaces are to be equipped also. Stokers often accomplish a fuel saving of from fifteen to thirty per cent and use the cheapest grades of coal, as well as minimizing the labor problem. Thus we see that the combustion engineer is proving his worth and making smokeless operation pay. More and more it will be realized that dense smoke issuing from a stack spells not activity, but inefficient operation.

Collegiate Night on WGY ---January 30

With more than 300 former students of universities and colleges from all over the United States expected to participate, what is believed to be the first intercollegiate night on the air is to be broadcast from WGY, the General Electric Company broadcasting studio here. Friday night, January 30, 1925, has been tentatively set as the date for this unique program.

Well known college airs will be sung by groups from the various institutions represented, following which each group will give the best of its college cheers. An intercollegiate quartette comprised of the best voices to be found among the membership of the Edison Club, the General Electric college men's organization will sing several numbers, and numerous instrumental numbers will be rendered by the Club orchestra.

Intercollegiate night on the air is being sponsored by the Edison Club. Those in charge of the affair state that Schenectady is one of the few places in the country from which such an entertainment could be broadcast. They base this statement on the fact that there are more young college graduates here than in most cities, since so many graduates join the General Electric forces immediately upon finishing college.

Could You Imagine---

Finding that Graves had given up playing pool on the "Y" table.

Seeing "Deacon" Mayrose have six dates in one week.

Professor Settles giving "lots of exemptions."

Louie Sisson being original.

"Humbert" Aitken with a mustache.

Red Sweeney as an evangelist against rum.

'Doc' White as a buck and wing dancer.

Schlossberg and Utt flunking eight or ten credits.

John Barr bumming a "chaw" of plug from "Tuffy" Watkins.

Lafe Stewart being on time to every one of his "eight-o'clocks."

Paul Crane with his hair a la Valentino.

Dick Brown with no girls to love him.

Phil Minnis agreeing with anyone.

Harold Schoonover as a waiter in King Lem's.

Such Junk as this being printed.

The Production of Helium

Gustave Pfeiffer, '25

DURING the solar eclipse of August 18, 1868 Janssen noted in the solar chromosphere a bright yellow line near to, but not identical with the sodium lines. Because it was not referable to any terrestial substance, it was ascribed to a hypothetical element called helium from the Greek word Helios meaning sun. It was not until 1895 that this characteristic line was discovered in the earth's atmosphere. In the same year Ramsey and Travers isolated it.

It is widely distributed in nature but in quite minute quantities. In air it is in the ratio of 1 volume to 250,000 volumes. It belongs in the series of inert gases which are argon, krypton, kenon and neon. Helium is the second lightest element known, hydrogen being the first. Although it is twice as heavy as hydrogen it has 92.6 per cent of the ascensional power of hydrogen in baloons. Both hydrogen and helium are so light when compared with air that their comparative lifting powers are not widely different; that is, 1000 cubic feet of pure hydrogen will lift 75.14 pounds, while the same amount of helium will lift 69.58 pounds. In physical behavior, it is the nearest approximation to a perfect gas. It has been proved to be the end product of emanations from radioactive substances.

Up to 1918 helium was a curiosity in laboratories. The total quantity produced up till that time did not exceed 100 cu. ft., and the cost of production ranged from $1700 to $2000 per cubic foot. Helium is now produced by extracting it from natural gases. The first plant to produce on a commercial basis was the Linde Plant located in North Fort Worth, Texas and built in 1918. It operated on a natural gas having .9% by volume of helium. The Linde Plant at first made a gas containing 28% helium. One month later the purity had reached 50%. Six months later they were making 7700 cubic feet a day having a purity of 67% and which could, upon repurification, be brought up 92%-93%. The cost of building this plant was about $300,000. Another plant built here was the Claude Plant based on the plans of George Claude, a Frenchman. This plant cost about one half that of the Linde but is considerably behind it in the matter of production. The third plant built during the war was the Jeffries-Norton which was to operate in conjunction with the U. S. Bureau of Mines. On account of experimental difficulties, however, this plant did not produce during the war. A very great reduction in the cost of production is expected when this plant operates. At the time of the signing of the Armistice, the first shipment of 147,000 cubic feet of 93% helium was on the docks ready for shipment. This at the above cited pre-war prices would have represented $250,000,000 worth of gas.

The separation from natural gas depends fundamentally upon the fractional distillation of gases through compression, which induces heat and subsequent expansion, and this, in turn, produces refrigeration. Although all of the processes above mentioned differ somewhat in specific details, yet the general underlying principle is the same. The liquefaction and reevaporation of single gas will be considered first. The ideal condition is that of perfect heat interchange horizontally between the vertical legs of the condenser and also perfect heat insulation in the outer chamber. If these conditions are answered and the whole system is brought to a steady state by some outside cooling agent, a gas which is passed through would tend to liquify and be at the bottom of the tube and a uniform temperature gradient would be established between the two legs. Even if the outside source were now taken away, the gas would still progressively cool, liquify, reevaporate, and revert to atmospheric temperature.

Whatever leakage there is in the walls of the insulating chambers and in the legs themselves is not a loss of energy, but a loss of availability. Hence to supply this loss, external work must be done. If we have, as in the case of natural gas, a mixture of gases instead of a single gas, their different points of liquefaction will tend to make still greater losses of availability and hence require more external work to be done. The problem therefore is to provide refrigeration at the proper temperatures and places.

In practice, one of the legs is developed into a column still which operates on the same principle as that used in the rectification of ordinary liquids. Hence, as the gases progressively liquify, they pass off and the helium is retained as a gas, because it cannot be liquified by any of these processes.

Helium furnished by the Linde Plant cost $146 per 1000 cubic feet. The navy department has a plant situated at Fort Worth with a rated capacity of 30,000 cubic feet a day and with a cost of production of $56 per 1000 cubic feet. The Bureau of mines thinks that when the Jefferies-Norton process is improved, that it will produce helium at $20 a 1000 cubic feet.

The storage of the helium after it was produced has been quite a problem in itself. Heretofore it has been stored in steel tanks under a pressure of 2000 pounds, each container holding about 200 cubic feet of helium when expanded to atmospheric pressure. The construction of such containers has mounted well into the millions of dollars. Experiments were conducted as to the feasibility of other methods of storage. Up to date the most satisfactory places of storage seem to be especially prepared chambers located in mines.

Although many uses will undoubtedly be found for helium, its most promising field of application seems to be that of aerial navigation. It is of prime importance in this field because of its buoyancy, rate of diffusion and its extreme inertness. Hydrogen because of its extreme inflammability has been a very serious menace to aerial navigation. Helium will retain its buoyancy one third longer than hydrogen. The use of helium will also greatly benefit the efficiency of the motive power of the aircraft. Heretofore the engines of the dirigibles have been placed in underslung gondolas well removed from the gas bag and hence also out of line with the longitudinal axis of the bag, causing the propellers to exert an off-center thrust which reduces the driving power of the engine. All of these objectionable features can be done away with by the use of helium. The use of helium in lighter-than-air craft will be a very great benefit both in time of peace and more so in time of war.

Decimal Point Determination in Slide Rule Operation*

James Theron Rood

Professor of Electrical Engineering, University of Wisconsin

The intelligent use of the slide rule is a mystery to most beginners—This is an attempt to simplify an apparent mysterious operation and fills a long-felt want

OF THE tremendous army of engineers using the slide rule to a greater or less degree, very few are able to readily and accurately locate the decimal point in the series of figures obtained in even the simplest of slide rule operations. Where the calculation is simple, involving simple multiplication or division only, the position of the point is usually obtained by guess work or else by some approximation method, worked either mentally or on the fingers. If the computation is a multiple term multiplication, division of both, such as an extended, complex fraction, these methods generally fail and the computer is left in uneasy doubt as to whether or not he has rightly guessed where the point should be. Further, the time required for these approximation methods is often so great that the actual time taken in determining the correct row of digits in the answer may be the least part of the operation.

TRY THIS ON YOUR SLIDE RULE

If the total minutes lost daily through use of inefficient methods of placing decimal points were multiplied by 150, the approximate number of rules in this school, how many man-hours per day would be wasted? Second: Because of inaccuracies due to the same inefficient methods, how many grade points are lost per school year? In this article Prof. Rood points out the absurdity of using these slipshod methods and offers to students and other readers a method which has been proved thoroughly practical.

That this is poor engineering as well as poor efficiency must at once be admitted. That it tremendously limits the use as well as the usefulness of the slide rule in engineering offices is well known to every expert practicing engineer. There are, indeed, many offices where the use of the slide rule is strictly prohibited, since too much danger to life and limb as well as to invested dollars may arise from a misplaced decimal point.

Such inaccuracy and uncertainty is absolutely unnecessary, even in the most complicated arithmetical operations. There is no good reason why the slide rule should not be used in any engineering calculations unless very close precision is demanded, greater than that which can be had with a slide rule. Even this objection can be questioned in most cases. An accuracy of better than one-tenth of one per cent should habitually be had with the ten-inch rule and one of the order of a twenty-fifth of one per cent with the twenty-inch rule, even without the use of the cylindrical lens on the cursor. Further, a very considerable number of engineering computations are based primarily upon values resulting from observations that have themselves been obtained with common types of measuring instruments, the readings of which are very seldom reliable to a tenth of one per cent and very often not reliable to better than one-fifth of one per cent. One of the absurdities encountered time and again in computation work is that of seeing calculations based upon such uncertain data carried out to the third or fifth decimal point by laborious hand or calculating machine operation.

A simple, quick method is available for determining the location of the decimal point with absolute exactness in even the most complicated computations. This method can be readily understood and applied, can be used with every type of slide rule operation and with it available there is no excuse for the restricted and half hearted use of the slide rule that exists at present among engineers.

I. Multiplication. Fundamental Theory. If the rule is set for the following simple two-figure multiplications

$$\surd\ \ \surd$$
$$2 \times 8 = 16 \quad (1)$$
$$\surd\ \ \surd$$
$$2 \times 80 = 160 \quad (2)$$
$$\surd\ \ \surd$$
$$2 \times 8{,}000 = 16{,}000 \quad (3)$$
$$\surd\ \ \surd$$
$$2 \times 0.8 = 1.6 \quad (4)$$
$$\surd\ \ \ \ \surd$$
$$2 \times 0.0008 = 0.0016 \quad (5)$$
$$\surd\ \ \ \ \surd$$
$$0.2 \times 0.008 = 0.0016 \quad (6)$$

the following points will be noted. First, in all these operations the slide projects to the left of the rule and this is true independent of the order of taking the numbers as well as whether the top or bottom scales

*Courtesy Wisconsin Engineer.

are used. That is, it makes no difference which num- is set on the rule and which on the slide, or whether the A-B or C-D scales are used. Second, in examples (1) to (4), inclusive, the number of places or digits in the answer to the left of the decimal point is equal to the sum of the number of digits to the left of the decimal point in the two numbers multiplied together. Third, in examples (5) and (6) the location of the point will be found by counting the number of positive digits, those to the left of the decimal point, in either of the numbers and from it subtracting the sum of the number of zeros to the right of decimal point before the first significant figures.

The negative number will be the number of zeros to the right of the decimal point before the first significant figure in the answer.

Similarly wit hthe multiplications

√ —
2 x 4 = 8 (7)

√ —
2 x 40 = 80 (8)

√ —
2 x 4,000 = 8,000 (9)

√ —
2 x 0.4 = 0.8 (10)

√ —
2 x 0.0004 = 0.0008 (11)

√ —
0.2 x 0.004 = 0.0008 (12)

the following points will be noted. First, the slide projects always to the **right** and this is again true independent of the order of setting the numbers as well as of the scales use. Second, in examples (7) to (10), inclusive, the number of digits to the left of the decimal point in the answer is **one less** than the sum of the digits to the left of the decimal point in the two numbers multiplied together. Third, in examples (11) and (12), the location of the point will be found by counting the number of positive digits in either of the numbers and from it subtracting the numbers of negative zeros, those to the right of the decimal point before the first significant figure. Add one to this negative number and it will be the number of zeros to the right of the decimal point before the first significant figure in the answer.

Multiplication of Two Numbers. (1) If either of the numbers is raised to fractional power or root, replace it by its evaluation. (2) Start the multiplication with either of the numbers, placing above this number a positive check (√). (2) Set the slide to multiply by the second number and read on the rule the digits series resulting. (3) Over this second number place a positive check (√) if the slide projects to the left beyond the rule and a negative check (—) if the slide projects to the right. (4) For the positive count add up the total number of digits to the left of the decimal point in the two numbers. (5) From this positive count subtract as negative count, (a) one for the negative check, if there is one over the second number, (b) the sum of the zeros to the right of the decimal point before the first significant figure in either of the numbers if they are decimal fractions. (6) The resulting difference (algebraic sum) will be, (a) if positive, the number of digits in the answer to the left of the decimal point, (b) if negative, the number of zeros to the right of the decimal point before the first significant figure in the answer. The positive checks are not counted but should be placed over the numbers to be certain that each number has been used as an operator.

If there is any question about remembering which projection gives the positive check and which one the negative, it is a simple matter to scratch a positive check (√) on the right hand end of the rule, darkening the scratch with ink if desired, and to put a similar negative check (—) at the right hand end.

The counts for the problems given are as follows:

	Example Number											
	1	2	3	4	5	6	7	8	9	10	11	12
Count:												
Positive digits	2	3	5	1	1	0	2	3	5	1	1	0
Negative: sum of												
(a) negative checks	0	0	0	0	0	0	1	1	1	1	1	1
(b) zeros to right of point	0	0	0	0	3	2	0	0	0	0	3	2
Result:												
Positive: digits to left of point	2	3	5	1			1	2	4	0		
Negative: zeros to right of point					2	2				0	3	3

This rule may be extended and applied to multiplication of any number of terms. Start with anyone of the terms, placing a positive check above this term. Alternate the setting of the slide and the hair line of the cursor, reading o nthe rule, after the last multiplication, the resulting digit series. Place above each of the numbers as used a positive or negative check according to whether the slide projects in each case to left or right. The order of multiplication of the terms is immaterial. Example:

√ — √ √ —
125.63 x 47,937 x 0.0000094 x 0.00305 x 1,384,792 = ? (13)

Digit series	2391		
Count:	Pos.		Neg.
Positive digits	15		
Negative checks			2
Negative zeros			7
	—		—
Result:	15	—	9 = 6

Answer: 239,100.

Multiplication of Several Terms: (1) If any of the terms are raised to any fractional power (root) evaluate them before proceeding with the multiplication. (2) Start with any one of the terms, always placing above it a positive check, and setting on the body of the rule. Set the proper end line of the slide over this number and place the cursor line opposite any second term, set on the slide. Against this term place a positive or negative check according as the slide projects to the left or right hand of the body of the rule. (3) Leaving the cursor untouched, place the proper end line of the slide under the cursor line, then move the cursor along the slide until it registers over a third term, read on the slide. Continue in this way until the last multiplication is made, placing a proper check against each term. Read the digit progression on the A or D scales, according to whether the A-B or C-D scales have been used. (4) In case a term is raised to an integral power (a) use this term as many times as a multiplier as its power, placing against it a proper check for each time it is so used, (b) count its positive digits or its negative zeros over as many times as the given power. (5) Count the positive digits, those to the left of the decimal point. From this subtract the sum of (a) al lthe negative checks, (b) the negative zeros, those before the first significant figure to the right of the decimal point. A positive difference gives the number of digtis to the left of the decimal point in the

answer, a negative difference gives the number of zeros to the right of the decimal point before the first significant figure in the answer

Examples:

$\sqrt[3]{85} \times 62.5 \times \sqrt{3} \times 550 = ?$ (14)

√ √ — √

$4.38 \times 62.5 \times 1.73 \times 550 = ?$

Digit progression 2609

Count: $7 - 1 = 6$

Answer: 260,090.

√ –√– √ √–√ –

$1.25 \times (3.14)^3 \times (0.00625)^4 \times 2{,}365{,}192 = ?$ (15)

Digit progression: 1397

Count: $11 - 11 = 0$

Answer: 0.1397

II. Division. Fundamental Theory. If the following simple divisions are performed on the rule

√			√		
$\frac{40}{5} = 8$	(16)		$\frac{50}{4} = 1.25$	(21)	
√			–		
√			√		
$\frac{4}{5} = 0.8$	(17)		$\frac{5}{4} = 1.25$	(22)	
√			–		
√			√		
$\frac{4}{50} = 0.08$	(18)		$\frac{5}{40} = 0.125$	(23)	
√			–		
√			√		
$\frac{0.04}{.5} = 0.08$	(19)		$\frac{0.05}{4} = 0.0125$	(24)	
√			–		
√			√		
$\frac{0.04}{0.005} = 8.0$	(20)		$\frac{0.05}{0.004} = 12.5$	(25)	
√			–		

the accompanying rule for simple division is readily established.

Simple Division. (1) If either of both terms are raised to fractional powers, evaluate them first. (2) Against the dividend (numerator) place a positive check. Set this number on the rule (D or A) by the aid of the cursor. Under the cursor line set on the slide (C or B) the divisor (denominator), placing against it a positive or negative check acocrding as the slide projects to the left or right. Read the resulting figures on the rule (D or A). (3) As a positive count sum up (a) the positive digits in the dividend, (b) any negative check against the divisor, and (c) any negative zeros in the divisor. (4) As the negative count add (a) the positive digits of the devisor, (b) any negative check in the dividend. (5) The algebraic sum gives, (a) if positive, the number of digits to the left of the decimal point in the answer, (b) if negative, the number of zeros to the right of the decimal point before the first significant figure in the answer.

This can be enlarged to cover extended fractions of the type so frequently met with in engineering computations. It is this type of equation that shows the slide rule in its greatest saving of time and energy. It is, however, the type of calculation that a large percentage of engineers can not correctly perform on the slide rule.

√

4.472 — √ – – — √ — — √

—

$$\frac{\sqrt{20} \times (17.8)^4 \times 1{,}874{,}900 \times 0.000945 \times (0.00018)^3}{(3.14)^2 \times 33{,}000 \times (84{,}950)^3 \times (0.0000015)^2 \times 8{,}450{,}000}$$

– √ – √ √ √ – – √

Digit progression: 1223

Count:	Pos.	Neg.
(1) Positive: sum of		
(a) positive digits in numerator	16	
(b) negative checks in denominator	4	
(c) negative zeros in denominator	10	
(2) Negative: sum of		
(a) postive digits in denominator		29
(b) negative checks in numerator		6
(c) negative zeros in numerator		12
	30 —	47=—17

Answer: $12\text{-}23 \times 10^{-16}$

Extended Fractions. General Rule. (1) If there are any terms raised to a fractional power, obtain the evaluation and substitute it for the term. (2) Start with any term in the numerator, placing a positive check above it always. (3) Multiply this number successively by the other terms of the numerator, taken in any order, placing above each term a positive or negative check according as the slide projects to the left or right when that term is used as an operator. (4) When the last term in the numerator has been used as a multiplier, move the cursor to bring the hair line over the end line of the slide, then set any term of the numerator on the slide under the cursor line, placing a positive or negative check against the term according to the projection of the slide. Then divide successively by the remaining terms of the denominator, giving to each term its proper check. Read on the rule the final digit series. (5) In case any terms are raised to an integral power, use this number as multiplier or divisor as many times as the indicated power, (a) putting a proper check against the term for each time it is used as an operator, (b) the positive digits or negative zeros, as the case may be, are to be counted as many times as the power. (6) To obtain the point location, take the algebraic sum of the positive and negative counts, obtained as follows:

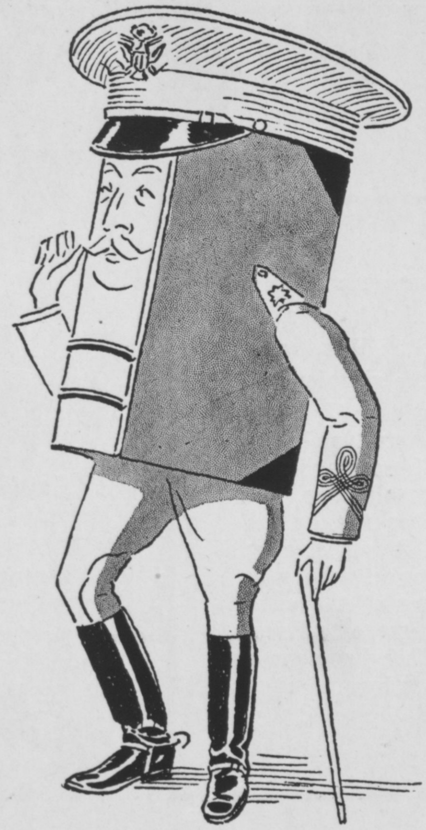
(a) Positive count: sum of—
- (1) positive digits in numerator
- (2) negative checks in denominator
- (3) negative zeros in denominator

(b) Negative count: sum of—
- (1) positive digits in denominator
- (2) negative checks in denominator
- (3) negative zeros in numerator

If the sum is positive it represents the number of digits to the left of the decimal point in the answer, if negative, the number of zeros to the right of the decimal point before the first significant figure in the answer.

Extended Fractions. Alternate Method. A varia-

(Continued on Page 31)



ALUMNI NOTES

(All Alumni are invited to send in personals of themselves or fellow Alumni)

The death of Dr. Johonnott has been keenly felt by all men who have ever been associated with him at Rose, and the TECHNIC has been the recipient of many sets of resolutions passed by Tech Clubs, the faculty, and the student body. There is not room in these pages to print verbatim all these resolutions, but the TECHNIC staff wishes to add its own deep sympathy, and it will keenly feel the loss of Dr. Johonnott who was always a staunch supporter of the publication and a reliable source of advice.

The Pittsburgh Tech Club has sent a letter to all of its members to announce the death of Dr. Johonnott.

1900

C. A. Mees, nephew of Dr. Mees, visited the institute December 10. His present address is 616 Johnston Bldg., Charlotte, N. C.

Thomas D. Witherspoon, with the Carnegie Steel Co., of Youngstown, is acting as instructor in Building Construction at the Youngstown Institute of Technology.

1910

P. F. Stokes is with the Victor X-Ray Corp., at Chicago.

Earl D. Hay is Dean of the College of Engineering at the University of Wyoming, at Laramie.

1913

J. F. Cronin is assistant engineer of the Toledo and Western Railway Co., at Sylvania, Ohio.

E. E. Hughes is in the real estate business at Miami, Florida.

1919

Tyler, who has been in Central America for some years is now in Conneaut, Ohio, address Box 19.

1920

J. F. Reinking, with the U. S. Gypsum Co., has been transferred to Plasterco, Va.

Andrew Brophy is engineer of design in the construction department of Swift and Co., Chicago.

1921

Irvin R. Weir, who has been establishing radio stations in South America for the General Electric Co., was home for Christmas.

H. Fitzsimmons has been made Assistant Superintendent of the Continental Products Co., Euclid, Ohio.

C. R. Voges has been made assistant professor of chemistry at the Texas A. and M. College.

C. Schroeder is leaving the General Electric Co. on January 1st, to work for the Coon-Deviser Co., Detroit.

1922

E. S. Whitlock is with the American Well Works at Aurora, Ill.

Duncan Baker is assistant engineer for the Associated Oil Co., 786 Pacific Electric Bldg., Los Angeles.

F. F. Hunt is assistant office manager with the Link Belt Co., Indianapolis.

K. DeBlois is in Warren, Arizona, as designer of concrete and steel for A. G. McGregor.

R. Failing is with the Barrett Co., Chicago. His address is 3150 Jackson Blvd.

E. O. Hunt, who has been with the Truscon Steel Co., Youngstown, is to be transferred to Portland, Oregon on February 1.

Dwight Spencer is U. S. Mineral Surveyor at Las Vegas, Nevada.

A. R. Watson is power engineer for the Eastern Texas Electric Co., with headquarters at Beaumont.

1923

H. A. Field, who is with Western Electric of Chicago, was a visitor at the Institute on December 13.

H. R. Kinkle was a visitor on December 22.

J. E. Albright and J. W. Anstead are with the General Electric Co., Schenectady, N. Y.

A. E. Woolen is with the Standard Oil Co., Bakersfield, Calif.

Harve Chinn is a superintendent with the Dull Bros. Construction Co., Arcannin, Ohio. Mr. and Mrs. Chinn announce the birth of Harve N. Chinn, Jr.

H. Johnson was a visitor on December 22.

1924

The marriage of Helen Chunn to Maurice Loser took place on December 28. Mr. Loser is with the Sinclair Oil Co., East Chicago, Ind.

D. Bundy is working for the Standard Oil Co., Taft, Calif.

S. L. Freers is in the engineering department of Pettibone and Mullikin at Chicago.

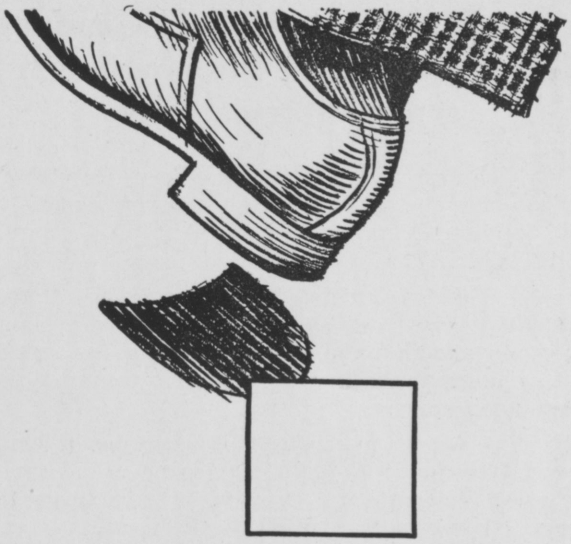
1925

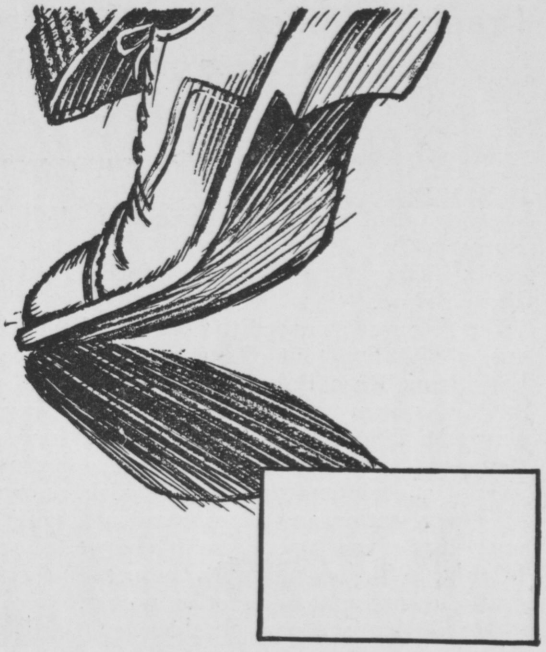
W. L. Wilson, ex '25, is teaching school at Coalmont, Ind.

J. B. Wilson, ex '25, is planning to enter the University of Southern California next term.

E^n Holds Initiation

En, the Rose honorary scholastic fraternity elected and held its fall initiation just before the holidays. The seniors who were honored for their proficiency in the field of knowledge were, White, McIntosh, Anderson, Ewers and Jenkins. The highest ranking junior who was also pledged was E. Wayne Watkins. Present members who were elected last spring are Barr, Dunning, Feldstein, Pfeiffer, and Motz.





Footprints

Put a print of your sole alongside a print of your heel. Then you see part of the reason why soles wear longer than heels—why you must have your heels rebuilt twice or oftener, to every new pair of soles.

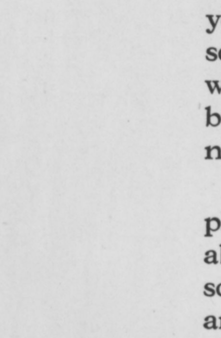
"Load area" is the technical explanation. Your heels have only about one-third the area of your soles. Your shuffles and weight are distributed over one-third less space. Hence the more rapid wear.

All this leads to Timken Bearings. The rectangle beside the sole print above shows the relative "load area" of a roller bearing as contrasted with bearings of other types (see square by heel print).

Put a bearing at the pinion gear of an automobile, or in the differential. Here the slightest effect of wear is to put the gears out of alignment—with deadly results.

But because of larger load area, wear in a Timken Bearing is so slow as to be unnoticeable during the life of the average car. And even if it should occur, a turn of a nut counteracts its effects. After thousands of miles, a Timken Bearing can be readily adjusted so that it's as good as new again. In which important characteristic, Timken Bearings are unlike *either* soles or heels!

THE TIMKEN ROLLER BEARING COMPANY
CANTON, OHIO
Columbus, Ohio—Walkerville, Ont.—Birmingham, England—Paris, France



TIMKEN
Tapered
ROLLER BEARINGS

Frank H. Miller Now Vice-President and Manager of Louisville Railway Co.

Frank H. Miller, Rose, '96, formerly vice president in charge of engineering, is elevated to the post of vice president and general manager of the Louisville Railway Co.

Mr. Miller is a graduate of the Louisville Male High School, class of 1891, and Rose Polytechnic, 1896. He was awarded the degree of electrical engineer in 1899 and that of mechanical engineer in 1914, both from Rose Poly.

He has been with the Louisville Railway Company since the fall of 1895, occupying the successive positions of car repairman, assistant superintendent of shops, superintendent of wirework, superintendent of power station and superintendent of motive power, until made vice president in charge of engineering in July, 1920, having supervision over the track, real estate, equipment and motive power.

Mr. Miller is a past president of the Electric; the Engineers and Architects; and the Rotary Clubs of Louisville. In addition to these he is a member of the Board of Trade, Transportation Club, Pendennis, Sleepy Hollow, Louisville Country, Louisville Boat, Automobile, Elks, American Institute of Electrical Engineers and the American Institute of Mechanical Engineers. He is a director of the Louisville Y. M. C. A.; member of the Executive Committee of the Boy Scouts of Louisville and member of the Executive Committee of the American Electric Railway Engineering Association.

Mr. Miller is the father of five children, his only son the oldest, graduating June, 1925, from the Massachusetts Institute of Technology.

Prof. Thomas Speaker at Oil Driller's Assn.

Prof. H. A. Thomas, formerly of the Civil department here, passed through the city December 20, on his way from Fort Worth, Texas, where he read a paper on Seamless Well Casings, before an Oil Drillers' Association.

TO OUR SUBSCRIBERS:

The numerals that appear on your envelope in which The TECHNIC is mailed are the numbers corresponding to the expiration date of your subscription.

Thank You.

George F. Nicholson, Poly Graduate, Given Important Post by Southern California City

Mr. Nicholson, a graduate of Rose Polytechnic, who has been in the northwest for several years, has been appointed harbor engineer at Los Angeles, Calif.

Mr. Nicholson is hailed in California and, indeed, along the west coast as an international authority on port construction and maintenance and his appointment came from the board of harbor commissioners almost unanimously.

His work wil lbe in conjunction with that of Major-General Lansing H. Beach as consulting engineer for the harbor department. Previous to this promotion, George Nicholson was chief engineer and executive secretary of the port of Seattle, a post combining what is usually included under a harbor engineer's office with executive administration of the depart. ment. This appointment follows a general reorganization of the department on a more effective basis, according to California papers.

Mr. Nicholson's new position will carry a salary of $10,000 a year. He will assume his position on January 1.

EXCHANGES

"The most awful has came!" Several engineering school magazines are now publishing crossword puzzles with all the "crosswords" being of technical origin. The Penn State Engineer published one which ye exchange editor attempted to decipher but after profanitating at considerable length, abandoned it, as it was worse than one of Doc Sousley's mid terms.

Now, be it known, P. Crane of the Junior Mechs. is a composer of the pesky puzzles. Here's one Paul—"do yer stuff!"

We read in the "Idaho Boys" magazine where one of their freshmen wanted to sue the "Karo" company because their corn syrup hadn't done his feet a damn bit of good.

This was equalled at Rose when one of our yearlings was told that some new chandaliers had been bought for the school. Whereupon he gargles "what for—I don't know anyone that can play a note on such an instrooment!"

(All person's having heard the above will be excused from laughing.)

ROSE TECH CLUB OF CLEVELAND

At a noon meeting of the Rose Tech Club of Cleveland, held at the University Club, December 9th, 1924, reports of officers were read and the following elected officers of the club for the year 1924-25: President, Harry A. Schwartz; Vice President, Jay H. Hall; Secretary, Donald L. Griffith; Treasurer, Harry S. Richardson.

August H. Klotz, '93, of Sandusky, Ohio, attended this meeting.

ATHLETICS

BASKETBALL

As soon as the football season had been completed the athletes of Rose Poly turned their attention to basketball. The Inter-class series was run off first to give the coach a chance to look over his material and get a line on the men he could count on during the season which is by this time in full swing. The freshmen walked off with the Inter-class series and they seem to have the best combination. But, alas, they are freshmen and according to the rules of the Indiana Intercollegiate Conference we are not allowed to use freshmen in our games. This is a terrible handicap, on account of the size of the school but we must make the best of it and carry on.

The material in the upper classes isn't so good as it might be this year. Only two letter men are back and around these two Coach Clark must build a team. Captain Anderson and Schoonover are good basketball players and it is a big problem to find more players who will work in with these two. The varsity squad now numbers twelve men, Anderson, Schoonover, Shepherd, Franzwa, Fisbeck, Miller, Piper, Nicason, Glenn, Reinking, and Hillis. These men are all working hard, and if the results are as good as their efforts, we'll have a successful season. Whoopee! Let's go! Up and at 'em! Give 'em ——L!

VINCENNES U. 12—ROSE 5

Talk about your tight games, this sure was one. The good word seemed to be "guard close" for that was what happened. Both teams had as tight a defense as anyone would want and we were beaten by long shots made by the opposing guards. They didn't seem to be able to miss the ring when they shot from past the center of the floor. The forwards of the Vincennes, who were crack shots hardly got a shot during the game, so closely were they guarded.

The whole team played well in this game, but the outstanding stars for Rose were Anderson and Schoonover. These two men were always on deck, fighting to the last ditch. We'll make things hum for the boys from Vincennes when we meet them next year.

PURDUE 41—ROSE 10

This time the "Fighting Engineers" ran up against a much more powerful five and were beaten decisively. Purdue has one of the best teams in the conference this year and one of the best they've had in years. It's no disgrace to be beaten by an aggregation such as they put on the floor. Our boys did as well as could be expected of them in the face of overwhelming odds. The game was fast and hard fought, but Purdue made the more points, and after all, that is who wins in basketball. Wait till the Engineers start hitting the old rim; then look out everybody.

E. I. S. N. 28—ROSE 9

This game was marred by poor refereeing, and poor refereeing will sure spoil a basketball game. It wasn't favoritism for any one side in this game; it was just poor refereeing as a basketball game. This was one of the best football games the writer has ever seen. Tackling, blocking and making touchdowns was the favorite sport. It seems that we didn't make the best use of it though, and we got the short end of the score. The teachers put the old ball through the ring when they had a chance; we didn't, that was the whole trouble.

Schoonover and Anderson bore the brunt of the defense in this game and there wasn't much offense. We'll get going first thing you know and then—!

EVANSVILLE 35—ROSE 4

It seems that Evansville holds the same old jinx over us that Louisville used to hold. When we got rid of the Louisville jinx last year in basketball and this year in football we thought everything was fine, but evidently the jinx just moved over to Evansville and hung around.

The "Fighting Engineers" went down to Evansville with blood in their eyes, determined to avenge the defeat in football, but they were turned back. The big long Studeville, who has been the bane of our existence ever since we've played Evansville, was again instrumental in bringing about the tragedy. He was responsible for most of the field goals and our consequent defeat.

Anderson and Schoonover shone for us. If the others were only as consistent as these two, we wouldn't worry. Let's go, after the holidays, and take 'em over.

Sophs Hold Annual Banquet

Held at the Elks club the night of December 16th the annual banquet of the sophomores demonstrated that their class spirit was not dead, but merely sleeping. With the characteristic energy and thoroughness that enabled them to win all of the class rushes, the banqueteers completely put to rout the six o'clock dinner served them. After this had been done to everyone's satisfaction, a faculty talk was given by Dr. Johonnott followed by a few remarks from Sweeney and Hillis, members of the class. A letter to Santa Claus asking for appropriate and needed gifts for the faculty and students was next read and with the cigars came the end. Credit for the success of the affair is due President Dunning and the committee in charge.

BRINGING MORE DAYLIGHT INTO INDUSTRIAL BUILDINGS.

Dr. George M. Price, writing on "The Importance of Light in Factories," in "The Modern Factory," states: "Light is an essential working condition in all industrial establishments, and is also of paramount influence in the preservation of the health of the workers. There is no condition within industrial establishments to which so little attention is given as proper lighting and illumination. Especially is this the case in many of the factories in the United States. A prominent investigator, who had extensive opportunities to make observations of industrial establishments in Europe as well as in America, states: "I have seen so many mills and other works miserably lighted, that bad light is the most conspicuous and general defect of American factory premises."

"My own investigations for the New York State Factory Commission support this view. In these investigations it was found that 36.7% of the laundries inspected, 49.2% of the candy factories, 48.4% of the printing places, 50% of the chemical establishments, were inadequately lighted. There was hardly a trade investigated without finding a large number of inadequately lighted establishments."

Inadequate and defective lighting of industrial buildings is not confined to the establishments in New York State alone. The same conditions prevail in most sections of the country.

Such conditions as mentioned above are entirely opposed to the laws of health, sanitation and efficiency. Wherever poor lighting conditions prevail, there must be a corresponding loss of efficiency and output both in quality and in quantity. American industry is not using nearly enough daylight and sunlight in its buildings. Every endeavor should be made to use as much as possible of daylight for lighting purposes. To obtain this it is of course necessary that the rays of daylight and sunlight are permitted to enter the interior of the buildings as freely as possible, with the important modification that the direct rays of the sun must be properly diffused to prevent glare and eyestrain. A glass especially made for this purpose is known as Factrolite, and is recommended for the windows of industrial plants. Windows should be kept clean if the maximum amount of daylight is to pass through the glass, but the effort will be well repaid by the benefits secured.

In the presence of poor lighting, we cannot expect men to work with the same enthusiasm as when a well lighted working place has been provided. The physical surroundings have a deep effect upon the sentiments of the employes, and where bad working conditions are allowed to prevail, there is invariably a lessening of morale and satisfaction created thereby. Neglecting to utilize what nature has so bounteously provided, daylight, and which is so essential toward industrial efficiency, we have an instance of wastefulness, but now that the importance of good lighting is becoming recognized, undoubtedly more attention will be given by progressive industrial employers to furnishing the means which are essential for their workers to secure and maintain the efficiency, which counts for so much in the success of any industrial concern in this competitive age.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,
220 Fifth Avenue,
St. Louis. New York. Chicago.

Ichabod—The glory is departed.

It has been said that the Prince of Wales of American masculine fashion is the college man. Whether or not the American undergraduate is followed as closely as his Royal Highness, it is apparent that the most colorful and extreme garbs of sport, afternoon, town, and country wear are to be first found upon the "Campuses of the centers of culture." An engineering school is usually not numbered among the latter, but they too have their local Beau Brummel who pave the way for the introduction for the fads and fancies. Hitherto, here at Rose these have been taken highly practical forms, eg. the recent one of adopting the army trousers, lumber jack shirts, sheep skins, and high top boots as the only outfit suitable for an aspiring engineer. When the chamois skin jacket swept the collegiate world the engineers balked—but alas compromised upon leather vests. It is thought that this concession to fashion proved the wedge whereby the most insidious vice of college entorial customs was able to creep in and secure a foot-hold at the Institute—namely the wearing of knickers. Long held in high esteem upon the university campus as the ideal garb for "those who care," the opinion of most of the followers of the elephant could be summed up—"all right for caramels and kindred species, but I quit wearing short pants in high school." The real objection, however, was that the "plus fours" and the accompanying trimmings ill-fitted the traditional "he-mannish' characteristics of the Knights of the Transits and Ohm. It seems that the breed of man from the open spaces who formerly were the pride of Rose halls has died out, else how explained that every year the number of men who can hit a goboon at ten paces grow fewer with a corresponding increase among the candy boys. It all started just after the Normal game when "Tater" Schilt, the BIG BOY from Olney, decided that as a football player he was a good finale hopper, so figuratively speaking, he gathered his loins about him and appeared in a pair of passionate panties. With a varsity sweater prestige and a good right arm to back him up he maintained the position he had assumed and was followed suit by some more campus celebrities until the situation is now beyond control so that a casual passer-by upon the National highway might think the present Rose plant is merely a gigantic country clubhouse. To date, nothing could be ascertained as to how St. Pat took the blow; a flip-flop in his tomb is the least that could be expected, but the present plan of some of his devotees to start a tea-room dedicated to the patron saint will probably result in his rising from his well earned sleep in protest.

Compulsory Physical Training Inaugurated

"Squads Right! On Right Into Line!" and like commands have ceased for the time being around the drill field, but the Military Nemesis is not dead. Instead the hard working under graduate is responding (stiffly at times) to "In cadence Exercise! Hands sideward, Raise!" In conjunction with the Athletic Board, a plan to secure mass athletics at least upon a small scale has been perfected, whereby all students in the frosh and sophomore classes, excepting the members of the varsity squads, are required to take twenty minutes a day for physical training. Rearrangement of the program was made so that no more time was required and no credit is given for the work. Every day at 11:55, calesthenics is dispensed by Lieuts. Hill and Bessell in the gym, and outside of the first few days' soreness the course is becoming decidedly popular, even more so than Foreign Language.

Advantages of Various Engineering Branches to be Discussed at Assemblies

It has long been said that the course of study at engineering school is practical to the Nth degree and a new step has been taken at Rose which fully bears out this assertion—assemblies, which at other schools are held for recreational and the most frivolous pastimes of higher education long have had at Rose an educational feature as a permanent part of the program. Usually in the form of a lecture upon a current engineering problem it has been endeavored to make this part of the exercises as interesting as the nature of the subject permits which naturally necessitates a loss in the application of the remarks. But a new plan has been affected whereby a definite return for the students one-hour has been made—briefly, an assembly will be given over to each department in which the head of that department will explain the opportunities, the nature of the work, and recent achievements in the branch of engineering he represents. It is thought that these discourses should be especially beneficial to the freshmen, who will obtain a more comprehensive view of the courses offered at the institute, thus enabling them to choose with more exactitude their life's profession. Dr. White of the Chemistry department gave the first talk of the series.

FRATERNITY NOTES

P. I. E. S.

On December 26, 1924, the P. I. E. S. held its annual Christmas dance at the Elk's club. The hall was beautifully decorated with two small lighted Christmas trees at either end of the stage and one large tree in the center of the hall. Santa Claus appeared and gave out small gold pencils to the guests as gifts. Ada Campbell's orchestra furnished the music for dancing. Dr. and Mrs. F. C. Wagner, and Prof. and Mrs. O. L. Stock were the honor guests.

Open house was held New Year's eve. The evening's entertainment consisted of a program of dances, the music for which was furnished by radio. Punch was served throughout the evening.

Several of the alumni visited the house during the holidays among whom were: Bennett, E. Hunt, F. Hunt, Hood, Maehling, Loser, Freers, M. Griffith, Weir, Failing, Faucett, Hocker, Williams, Goodman, Wilson, Bernhardt, Richards, St. Clair.

THETA XI

Preceding the Christmas holidays, Kappa staged its annual Christmas dance at the Elk's club. A number of the alumni were present among whom were Armstrong, Royer, Stockmaster, Anstead, Compbell, Bledsoe, Tetzel, Hartsook, Weinhardt, Turned, and Boyd.

The house staged several informal parties during the holidays for the alumni.

SIGMA NU

The first social affair of the season was a dance on December 19th. There have been dances, and there have been dances where an abundance of spirit was shown, but never in the history of dancing was there a dance like this. Pep, enthralling music, mistletoe, and old man Santa, himself, all combined to make the night a typical Sigma Nu night.

The house to which Beta Upsilon recently moved was attractively decorated with mistletoe and the Christmas colors. A large decorated Christmas tree stood in the front room around which the presents were heaped. Amid a great deal of merriment and laughter these presents were distributed by the fine, old gentlemen at the appointed hour. Due to the fatigue of the orchestra the affair was forced to end at one o'clock.

ALPHA TAU OMEGA

Gamma Gamma chapter of Alpha Tau Omega entertained with a Christmas formal dance on Monday evening, December 26, 1924. The house was attractively adorned in the season's colors and with "ye olde mistletoe" hung at convenient intervals. Ada Campbell's orchestra furnished the music. Punch was served and Santa Claus, himself, visited the dance distributing favors in the shape of bar pins with the fraternity crest. The guests were Prof. Hutchins, Brothers B. H. Pine, J. H. Loehr and R. D. Hayes of Purdue, N. C. Buckhart of California U., J. Maehling of Chicago, and J. Turner Browder.

McIntosh, Pflaging, Paige, Crutcher, and Ranahan attended the A. T. O. National Congress at Philadelphia, December 31, 1924 to January 3, 1925. The time was taken up by business sessions during the day and entertainment at night. There were 657 A. T. O.'s present at the congress, representing the eighty-four chapters. The founder of the fraternity, Otis Allen Glazebrook, journeyed from Nice, France, and took an active part in the proceedings. The next congress will be held at Jacksonville, Florida, in December, 1926.

The annual Christmas homecoming held on Christmas day each year at the chapter house was as usual a huge success. Some of the old boys who were present were Brothers Pittman; Paige, Haupt, Heyman, Froeb, Scott, Willson, Ranahan, and Belden.

Gamma Gamme feels deeply the loss of two of its brothers by the call of death:

Brother Chas. M. Struck, '10, was killed on January 5, 1925, at Louisville, Ky., when he fell from a building upon which he was working.

Brother Chas. W. Boland, 25, was killed January 7, 1925, at Terre Haute, Ind.

Mr. A. J. Bedard, who was at Rose as instructor in C. E. is to be married next month to Miss Sarah Compton, of Terre Haute.

Junior Prom On it's Way to Success

"The best ever" sounds decidedly hackneyed, not to say banal, when applied to a coming social function, but nevertheless it is the only possible appellation for the annual Junior Prom. One of the prime requisites —an early start has been achieved—and a glance at the committees in charge convinces one that a most capable crew will shoulder the responsibility of making this year's Promenade surpass the high standard attained since its revival two years ago. Tentative plans include obtaining an orchestra of known ability insuring music of the highest order. For the two previous Proms a concert orchestra has performed, Benson's of Chicago in each instance, and while much in favor of such an orchestra, the consensus of opinion is that the the music is the thing at a dance and the dance the thing at a Prom, it would be better to obtain the services of some nationally known music-makers famous for the quality of their music—such as the Wolverines, Cotton Pickers, etc. While nothing definite has been done upon the decorations, programs, and other features, committees are making a thorough survey of these fields to insure the latest, and it is confidently predicted that surprises of novelty and attractiveness will be the results of their labor. An especial appeal will be made to the alumni to secure as many of these to attend as possible.

The chairmen of the committees are: General chairman, George E. Himmelbauer; Music, Max Sherwood; Decorations, Harry Lewis; Finance, David Hoffman; Publicity, Hubert Swartz; Refreshments, Lafe Steward; Reception, Nelson Shepherd; Dress, Bruce Walsh.

A 1000-Ton Ice Plant

(Continued from page 8)

Five shallow wells furnish 300 gallons per minute of auxiliary cooling water at a temperature of 58° F. All five wells are connected into one common suction header, which supplies one 8-in. by 10-in., vertical single-acting, 300-g. p. m., triplex pump and two 6-in. by 8-in., 150-g. p. m. triplex pumps, located in the basement under the ice storage room. These pumps are geared to 15 and 7½-hp motors respectively. These pumps force the water through a 4-in. line to the liquid ammonia forecooler, consisting of 7 stands, 18 pipes high, and also to 10 stands of the thirty-six 2-in. pipes, used as a heat interchanger, through which passes the city water used in the intercoolers of the large ammonia compressors and in the vapor coolers. This system of heat interchange was adopted first, to avoid scaling up of the intercoolers and vapor coolers, which would have resulted by the use of the hard well water in this apparatus; second, to obtain cooling water at a temperature closely approximating that of the well water; and third, to reduce the Croton water cost.

A surge tank located near the ceiling of the condenser room keeps the pressure constant and prevents damage to the pumps.

After passing over the liquid ammonia forecoolers and the heat interchanger, the well water is quite warm and is used in the dip tank to thaw the ice from the cans. This warm water is collected in a pan below the above apparatus, and passes through a 4-in. line to two centrifugal pumps that force it to a storage tank on the fourth floor. There is one 4-in. horizontal double suction centrifugal pump, 300 g. p. m., 120 ft. head, connected to a 20-hp. motor, running at 1,800 r. p. m., and a 3-in. 150-g. p. m., centrifugal pump, driven by a 15-hp. motor used for this purpose. From the storage tank, it is distributed to the dip tanks on the various freezing tank floors and then passes out to the sewer.

In order to prevent scaling, New York City water is used for cooling the machines. It is forced by city pressure through the water jackets of the ammonia and air compressors to a house supply tank on the third floor. This water is used in the toilets, lavatories, etc., and in the winter time when the well water pumps and large compressors are not in use, the warm water is used in the dip tank and thawing needle system.

The overflow from the house supply tank flows to the surge tank of the closed system serving the vapor coolers and intercoolers. New York City water is circulated through the intercoolers of the three large machines, the vapor coolers, and the heat interchanger by two 2-in. and 4-in. centrifugal pumps, direct-connected to 5-hp. and 7½-hp. motors, respectively. One of these pumps is a spare for use in an emergency. From the intercoolers the water passes to the vapor coolers, located in the condenser room in which there are eight passes on the water side. After leaving the vapor coolers, it enters the heat interchanger referred to before and gives off its heat to the well water passing over it which is later used in the dip tanks. The heat exchanger consists of 10 stands, 2-in. pape, and 36 pipes high. From the heat interchanger, the cooled New York City

water goes back to the centrifugal pump to be recirculated.

New York City water is also used for ice making. Two 3-in., 2-stage, 200-g. p. m., 175-ft. head, centrifugal pumps driven by 20-hp. induction motors, take the water from the main through a 4-in. line and force it through three orifice manifold vertical pressure filters located on the second floor of the condenser house. These are 7 ft. inside diameter by 8 ft. 4 in. high, and have a capacity of 12,000 g. p. m. It is necessary to filter the Croton water used for ice making as otherwise the ice at times may show slightly yellow cores in the ice blocks.

After leaving the filters, the water rises to the two forecooling tanks (22 ft. x 22 ft. 4 in. x 6 ft.) located on the fourth floor. Here it is kept in circulation by agitators and cooled down to about 36° F. by means of expansion coils. A 4-in. line supplies the cooled water to the multiple can-filling tanks located on each freezing tank floor.

There are three freezing tank floors in the plant which contain fourteen freezing tanks, each holding 980 300 -pound cans or a total of 13,720 cans. Most of these tanks have been in service twenty-one years, but ts they were still in excellent condition, they were retained. The frames were notched and air laterals were installed with outlets, each supplying two cans. New double ice can covers were also installed.

For each two tanks, a direct-acting piston-type core suction pump is provided with a core sucker and core filler, the hose on the core suckers and fillers being of sufficient length to reach any can in the two tanks.

The brine is kept in circulation by 28 Dimco vertical agitators, two of which are installed on each tank. Each is driven by a 3-hp. vertical electric motor.

Owing to the arrangement of the freezing tanks and the location of the lowerators, a multiple-can hoist system could not be installed. However, an electric crane equipped with two one-ton, two-can hoists is installed in each of the fourteen tanks, so that either two or four cans can be pulled at a time, as desired. Fig. 14 shows the new frame work on one of the old freezing tanks.

These cranes have a span of 26 feet and travel at a rate of 150 feet per minute. Each is equipped with a 3-hp. motor for travel and two 1-ton hoists. The hoist speed is 25 feet per minute. The 28 hoists are controlled from the floor by handles. The bridge is also controlled from the floor by a special operating mechanism provided with an automatic tripping device for each end of the runway and arranged so that it can only be operated when both hoists are in the proper location on the bridge to suit the dip tanks.

Four cans are pulled at one time and carried to the end of the tank. They are lowered into the dip tank and then dumped, two at a time. All four cans are filled at the four-can Dimco automatic can filled installed on each freezing tank, and returned to the tank.

To deliver the ice to the ice storage floor, each freezing tank is equipped with an automatic pneumatic lowering machine, arranged for handling two cakes of ice on edge. Fig. 4 gives a view of the harvesting end of one of the freezing tanks, showing

cranes, hoists, can filling tank, can dumper, and ice lowerator.

The ice storage room is 136 ft. x 168 ft. 9 in. x 13 ft., equipped with cooling coils on the ceiling. It is large enough to store about 4,500 tons of ice, but owing to the fact that it is used as a daily ice storage room only about 2,500 tons are ever acutally stored at one time. A benching machine is used to stack the ice.

The entire front of the building on the 133rd Street side, with the exception of a small space used for the weighmaster's office, is used for loading purposes. It is about 150 feet long. Two doors from the ice storage room lead to this loading platform.

It is quite a problem to heat a plant of this size in the winter time. After careful consideration of the various heating systems of industrial plants, it was decided to use a special system of steam heating, with oil-burning equipment of the low pressure mechanically operated automatic type, which requires but little attention. The oil used in the boilers is stored in an outside tank. This tank has a capacity of 12,600 gallons, and has an 8-in. filler line, terminating in a fill box which permits the filling of the tank from tank trucks. A pneumercator, or pneumatic mercury oil measuring device is installed in the storage tank with an indicator gauge on the wall of the engine room, which shows at all times the quantity of oil in the tank.

A steam heating coil surrounds the 2-in. suction line which heats the heavy oil to a temperature of 100° F. and renders it fluid enough to be handled by the pumps. Two booster centrifugal pumps, direct-connected to one-fourth horsepower motors, running at 1,725 r. p. m., are installed on the first floor of the powerhouse to lift the oil up to the second floor, one of these pumps being kept as a spare. The combination oil pumps and air blowers, each driven by a one-half horsepower motor running at 3,500 r. p. m. are installed in the boiler room. They force the oil to the burners, and also supply the necessary air for atomization. A 1½-in. overflow line returns the surplus oil from the pump to the storage tank. From the oil pumps the oil passes through a steam oil heater in which the temperature of the oil is raised to about 175° F. An electric thermostatic heater brings the oil to a temperature of 180° F., automatically cutting off if the temperature exceeds that figure.

There is an auxiliary oil tank located in the boiler room which holds 60 gallons. This is used for starting the heating system after a protracted shut-down.

Two 75-hp. water tube boilers are provided to produce the necessary steam, each being equipped with two oil burners. Each boiler has its own apparatus from booster pump to burners and is so cross-connected that either boiler can be operated on either set of equipment. Normally a pressure of 10 to 12 pounds is carried in the boilers for heating, but this can be increased to 75 pounds if desired.

The steam generated is conveyed to the heaters in the engine room and other parts of the plant where heat is desired. These heaters are made on the principle of an automobile radiator, the only difference being that instead of cooling water they heat air.

A fan is mounted back of the radiator and forces air through it. As the air passes over the surfaces of the radiator, it is heated and blown into the room.

The condensate formed is pumped back into the

boilers by one of two receiver pumps, located in the basement. These pumps operate automatically and make is possible to use the same water over many times.

The plant is electrically driven throughout and has a connected load of 4,500 hp., including all duplicate and auxiliary units. Based on a 50 per cent load factor, it is capable of manufacturing 182,500 tons of ice per year, representing the current consumption of 7,600,00 kilowatt hours.

Every possible precaution was taken to insure continuous service, and for this reason, two separate feeders supply current to the plant, which is connected up on a double loop system.

These two distinct sources of supply are controlled and protected by a 3,600-ampere circuit breaker installed in the 13,200-volt feeder service between the coil switch and the transformers. Three switches are located in a fireproof vault in the engine room at the easterly end of the building.

Service is purchased on a high tension maximum demand rate, maximum demand being changed weekly. It covers the highest peak established during any fifteen-minute interval during the week. In order to take advantage of the maximum demand clause, compressors are provided with clearance pockets adjusted so that the plant can be operated with 95 per cent to 97 per cent load factor throughout the season.

Adjoining the switch room is the transformer vault containing four 1,250 kv-a. transformers. These transformers are designed for 15,000-volt primaries with taps to 13,200 volts and secondaries for 440 volts.

Transformers are connected up 3-phase delta. Any two transformers are capable of carrying the entire load operating open delta. The fourth transformer gives an additional factor of safety and the bus structure is arranged so that the fourth transformer can be cut in the event of failure of any of the transformers operating closed delta. Should any two of the transformers fail, the bus can be changed to open delta operation with but slight interruption to service.

In order to afford every possible protection against grounds, the fourteen cranes, each of them against grounds, the fourteen cranes, each of which are equipped with two hoists, are operated from separate banks of transformers. There are two banks of transformers, located on the second and third floors. Each bank consists of four Pittsburgh, 10 kv. a., 440-110 volt, oil-cooled transformers which are connected up in delta. The same provisions are made to insure continuous operation as in the case of the power transformers. The fourth or spare transformer can be cut in to replace any damaged transformer and the bank operated closed delta. Any two transformers are large enough to carry the full load operating open delta.

The switchboard is mounted in the gallery over the transformer room. The board consists of eighteen panels, ninety inches high, and is made of slate with black marine finish. This is prabably one of the most modern up-to-date boards installed in any industrial plant of corresponding capacity. Every possible arrangement was taken advantage of to insure simplicity of operation, each of maintenance, and accessibility.

The board is of the dead-front type, equipped with

a full set of metering instruments, including total output watt hour meter, curve-drawing wattmeter, voltmeter, ammeter, and power factor meter. It is equipped with an energizing panel which controls two sets of compensators for starting busses of synchronous motors.

Decimal Point Determination in Slide Rule Operation

(Continued from page 16)

tion upon the last method is to alternate the operation of multiplication and division, taking the terms alternately from numerator and denominator, in place of multiplying all the numerator terms then dividing by the denominator terms. The positive and negative checks and the method of count is the same. (1) After evaluating all root terms, set any one of the numerator terms on the rule by means of the cursor, then set any one of the denominator terms on the slide under the cursor line. (2) Now, without changing the slide, move the cursor until the line lies over another numerator term read on the slide. (3) Move the slide to bring another denominator term under the cursor line. Proceed in this manner, setting cursor, slide, cursor, slide, taking the number from numerator, denominator, numerator, denominator. Any excess terms left in numerator or denominator will have to be used as final multipliers or devisors as in the previous method. The only advantage of this method is that it shortens the time through decreasing the number of sets. It is, however, more liable to error in the hands of the beginner.

III. Reciprocals. The evaluation of reciprocals follows the general rule for fractions with one additional point to be strictly regarded; the **left hand** end line of the rule must be taken for the unity numerator. If the right hand end line is taken and the first divisor set against this, the digit series will be correct but the point count will place the decimal point one digit out of place.

Examples—

(a) using left end; correct position of point,

$$\frac{\overset{\checkmark}{1}}{\underset{\checkmark}{25} \times \underset{-}{0.02} \times \underset{\checkmark}{5}} = 0.4 \qquad (27)$$

$$3 - 3 = 0$$

(b) using right end; incorrect place of point,

$$\frac{\overset{\checkmark}{1}}{\underset{-}{25} \times \underset{-}{0.02} \times \underset{\checkmark}{5}} = 4.0 \qquad (28)$$

$$4 - 3 = 1$$

By writing out a number of examples, the rules for extended multiplication and for complex fractions can be quickly learned. The increase in speed of solving such equations and the feeling of certainty as to the location of the decimal point will repay many thousand fold the time and energy required to make these simple rules a part of the engineer's equipment.

Centers and Quarterbacks

A GOOD basketball center or football quarterback knows more than the resources of his team. He knows what resources to call upon at decisive moments. To him, the condition of his opponents, their weight and style of play, the time left to go—all dictate a strategy, which he follows.

There is in industry a group of engineers whose position resembles that of field general. They keep their eyes continuously upon all fields of human activity. They observe how each is affected by changing economic situations. They calculate what demands the future will make upon each. Then they bring to its aid new discoveries and beneficial methods.

In 1886, George Westinghouse saw that industrial growth could not be furthered by direct current alone. The "game" required a new style of play. So when the rudiments of a transformer came along—opening the way for alternating current, Westinghouse adopted both, perfected them, and paved the way for the electrical era of the present time.

In an organization like Westinghouse, these "quarterbacks of industry" are called "application engineers". They are mechanical and electrical engineers who apply the forces of electricity to every variety of human need.

Westinghouse application engineers first applied motors to the steel industry, the textile industry, the automobile industry. They introduced electricity to railroads and ships. They developed it for heating purposes.

Application engineers are needed in industry—they fill an important and expanding place. Westinghouse service to industry starts with their efforts.

Westinghouse

ACHIEVEMENT & OPPORTUNITY

WESTINGHOUSE ELECTRIC